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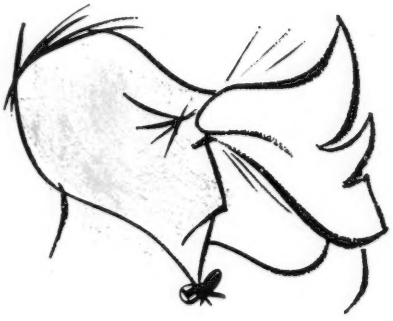

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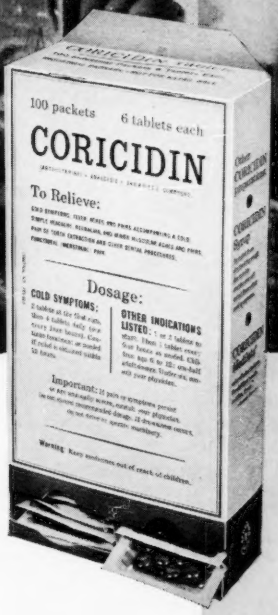

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The Industrial Medical Association was organized in 1915 as the American Association of Industrial Physicians and Surgeons. Its first annual meeting was held the following year. In 1951 the present name was adopted.

The purposes of the organization as stated in the certificate of incorporation (not-for-profit) are:

"The object of this Association will be to foster the study and discussion of the problems peculiar to industrial medicine and surgery; to develop methods adapted to the conservation of health among workers in the industries; to promote a more general understanding of the purposes of the medical care for employees; and to unite into one organization members of the medical profession specializing in industrial medicine and surgery for their mutual advancement in the practice of their profession."

Presently, the membership totals nearly 4000 physicians in the United States, Canada, Latin America, and other parts of the world. Physicians "who have an interest in Industrial Medicine" may apply for membership; specialization in this field is not essential. Regionally, the Industrial Medical Association has 13 Component Societies in the United States and one in Hawaii. Most Association members carry their membership through one of the component groups.

The Journal of Occupational Medicine, owned and published by the Industrial Medical Association, is sent monthly to each member as one of the advantages of membership.

The annual business meeting and convention is held in the spring. Since 1945, the convention has been held concurrently with the meetings of four other organizations having related interests—American Industrial Hygiene Association, American Conference of Governmental Industrial Hygienists, American Association of Industrial Nurses, Inc., American Association of Industrial Dentists. This combined meeting is known as the Industrial Health Conference.

The Occupational Health Institute, Inc., is a nonprofit educational organization created by the Industrial Medical Association to promote the cause of health in industry. Since 1951, the Occupational Health Institute has conducted the program of evaluation, approval and certification of Medical Services in Industry, on the basis of standards established by the Standards Committee of the Industrial Medical Association. This program was conducted by the American College of Surgeons for many years until its transfer to the Association.

The Association's headquarters office serves as a focal point for the Association's activities, and through its coordination of information regarding industrial health problems encountered throughout the country, it offers invaluable assistance to members on a host of specific subjects.

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An important function of the District Counselor is to serve in a liaison capacity with the Component Society of the Industrial Medical Association in his area. The District Counselor also is concerned with regional trends in industrial medical practice and in legislation bearing upon medical service in industry. He is ready to assist any physician with questions or problems.

In promoting the cause of industrial medicine, many District Counselors work with the industrial health committees of their state medical societies, they participate in teaching programs at hospitals or medical schools, and serve as speakers at meetings of groups that express interest in occupational health. Throughout these activities, the District Counselor attempts to stimulate membership in the Industrial Medical Association by acquainting others with the organization's purposes and facilities.

By keeping in close contact with members in his area, the District Counselor gains a familiarity with their work which enables him to make recommendations to the Association's officers and committees regarding those qualified for various positions or honors. He recommends members for committee work, and for fellowship, and recommends fellows for consideration for elective offices in the Association. He also recommends possible recipients for the awards presented at the annual meeting of the Association—the Knudsen Award, the Health Achievement in Industry Award, the Meritorious Service Award and the Merit in Authorship Award.

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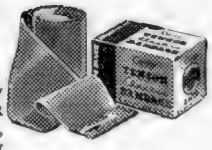

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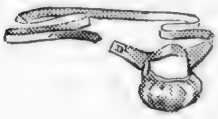

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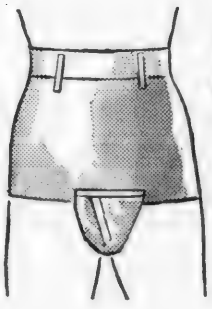

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Association Activities

PRELIMINARY PROGRAM FOR THE 44TH ANNUAL MEETING

SHERMAN HOTEL, CHICAGO — APRIL 28-30, 1959

Tuesday Morning

CLINICS:

General Surgery Clinic at St. Luke's Hospital—B. C. KILBOURNE, M.D.

Fracture Clinic at Cook County Hospital—C. SCUDERI, M.D., or J. J. CALLAHAN, M.D.

Rehabilitation Clinic at Rehabilitation Institute of Chicago—B. J. MICHELA, M.D.

Tuesday Afternoon

GENERAL SESSION:

Co-Chairman: R. B. ROBSON, M.D., Chairman, Geriatrics and Retirement Committee and D. W. CALDWELL, M.D., Chairman, Mental Health Committee.

Sappington Memorial Lecture—CAREY P. MCCORD, M.D. (Sponsored by the Occupational Health Institute.)

"The Older Worker and Retirement"—NATHAN W. SHOCK, M.D.

"Mental Health in Industry"—WILLIAM MENNINGER, M.D., and HARRY LEVINSON, PH.D.

Wednesday Morning

GENERAL SESSION:

Chairman: ASA BARNES, M.D., Chairman, Medical Care and Practices Committee.

"The Interrelation of Medical Care Plans in Industry, The Windsor Plan"—R. B. ROBSON, M.D.

"The Kaiser Medical Foundation"—H. A. LEWIS, M.D.

"Hotel Trades Medical Center"—F. P. GUIDOTTI, M.D.

"Coal Industry and the U.M.W. Welfare and Retirement Fund"—J. D. WINEBRENNER, M.D.

Co-Chairmen: W. D. NORWOOD, M.D., Chairman, Radiation Committee, and H. TEBROCK, M.D., Chairman, Chest Committee.

"Radioactive Sources, Discussion and Demonstration" — V. BEARD, PH.D.

"Somatic Effects of Radiation"—AUSTIN BRUES, M.D.

"Periodic Chest X-Rays in Industry—Benefits versus Radiation Hazards, Recommendations of the Radiation and Chest Committees of the IMA"—W. D. NORWOOD, M.D.

"Radiation Protection Standards in Industrial Practice" — LAURISTON S. TAYLOR, PH.D., or WILLIAM MCADAMS, PH.D.

Wednesday Afternoon

GENERAL SESSION:

"Arterioscierosis, Hypertension, Coronary Disease — Current Concepts"—LOUIS N. KATZ, M.D.

"Criteria of Aging—Clinical Aspects"—E. B. BAY, M.D.

"Criteria of Aging—Psychological Testing" — W. C. HALSTEAD, PH.D.

BUSINESS SESSION

Wednesday Evening

ANNUAL BANQUET

Thursday Morning

MEDICAL SECTION:

Chairman: J. F. JELLEMA, M.D., Chairman, Committee on Problem Drinking.

"Alcoholism in Industry — A Look at its Cause"—two speakers to be announced.

"Industrial Medicine—Some History and Background"—ALFRED H. WHITTAKER, M.D.

"Medical Aspects of Motor Vehicle Accident Prevention" — H. BRANDELEONE, M.D.

"Industrial Medical Service in the Small Plant (Nurse Working Alone)"—B. W. BROOKS, M.D.

"Logic in Liability Settlements"—CLEMENT MARTIN, M.D.

"Drug Testing in Industrial Clinics"—H. E. TEBROCK, M.D.

SURGICAL SECTION:

Chairman: E. A. IRVIN, M.D., Past President of IMA.

"Brachial Plexus Block for Hand Surgery — Experience at Henry Ford Hospital with 600 Cases"—J. W. DITZLER, M.D.

"Reconstructive Treatment of the Crushed Hand"—M. L. MASON, M.D., and J. L. BELL, M.D.

"Operative Treatment of Juxta Articular Fractures" — S. W. BANKS, M.D.

"The Multiple Injury Problem"—C. SCUDERI, M.D., and J. J. CALLAHAN, M.D.

"The Impartial Medical Examiner in Workmen's Compensation"—SAM LEVINSON, M.D., and HARRISON MCLAUGHLIN, M.D.

"The Rehabilitation Center's Function in a Community"—B. J. MICHELA, M.D.

Thursday Afternoon

MEDICAL SECTION:

"Health Problems in Industrial Use of Plastics"—R. H. WILSON, M.D.

"Beryllium Disease — Clinical Aspects" — HARRIET L. HARDY, M.D., and JOHN STOECKLE, M.D.

"Beryllium Disease—Experimental Studies"—A. J. VORWALD, M.D.

"Toxicology of Agricultural Chemicals, Pesticides, Fertilizers, etc."—MITCHELL R. ZAVON, M.D.

SURGICAL SECTION:

"Cardiac Resuscitation in Industry"—R. M. HOSLER, M.D.

"Follow-Up of Inguinal Hernia Repair with Tantalum Mesh"—C. C. GUY, M.D.

"Recurrent Thrombophlebitis"—D. I. ABRAMSON, M.D.

COMBINED MEDICAL AND SURGICAL SECTION:

"Occupational Skin Problems"—R. R. SUSKIND, M.D.

"Gynecological Survey in Industry"—MAC ROY GASQUE, M.D.

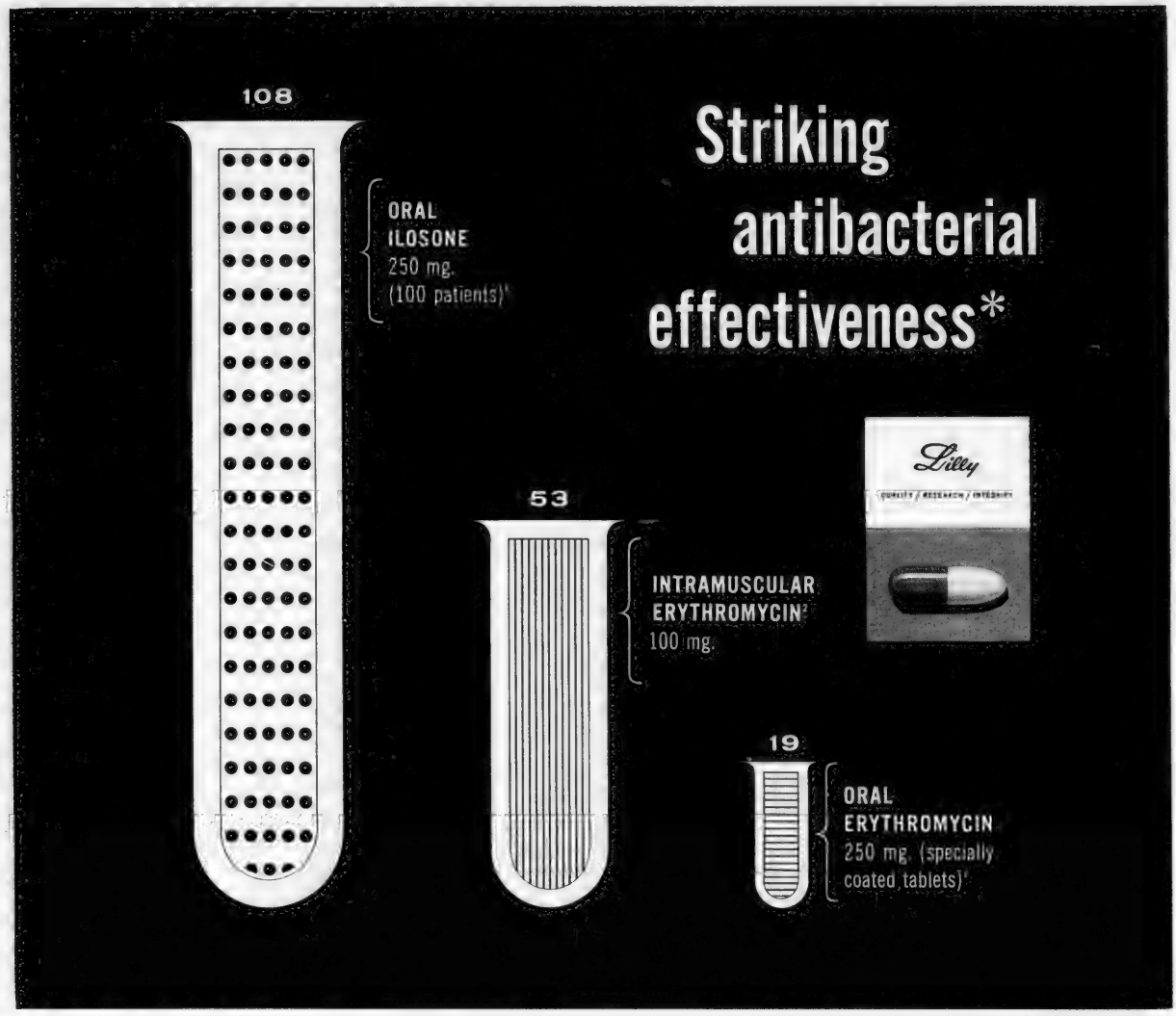
"Emotional Problems of Women in Industry"—S. G. ROGG, M.D.

14th Component Society

THE Board of Directors of the Industrial Medical Association has accepted the petition of the Minnesota Academy of Occupational Medicine and Surgery to become a component society of IMA. This followed action of the Board of Directors of the Central States Society of Industrial Medicine and Surgery setting aside from its jurisdiction the State of Minnesota and its Canadian bounding provinces.

The Minnesota Academy was organized early in 1954. Twenty-seven members of the Academy were already members of IMA, either directly or through the Central States Society, and the acceptance of the Minnesota Academy as a component society brings approximately 50 new members to IMA.

Officers of the Minnesota Academy of Occupational Medicine and Surgery are: T. E. BARBER, M.D., President; J. A. WILLIAMS, M.D., Vice President; R. W. GOLTZ, M.D., Secretary; B. I. BERAUF, M.D., Treasurer; and EARL OPSTAD, M.D., Recorder. The Executive Committee includes ORLEY FOSTER, M.D., JAMES R. FOX, M.D., and JOHN F. SHRONTS, M.D.



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1. Griffith, R. S., *et al.:* Antibiotic Med. & Clin. Therapy, *5*:609 (October), 1958. Note: Peak levels with the oral erythromycin tablets (thirty-three dilutions) were not observed until four hours after administration. 2. Data from Griffith, R. S.: Antibiotics Annual, p. 269, 1954-1955.

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Journal of Occupational Medicine

Occupational Medicine — Whither and How!

Robert A. Kehoe, M.D., Cincinnati

THE developments of recent years in the field of occupational health in North America have been noteworthy. With but few exceptions, the features which can now be recognized as milestones of substantial progress toward the present concept of this specialized form of medical activity have come into existence within the lifetime of men now actively engaged therein. It is even more significant that these milestones—the specialized professional organizations, the facilities and personnel for relevant research, the scientific and professional periodicals and reference works, and the organized disciplines for professional training—have achieved dimensions that have given adult stature to occupational medicine among other medical specialties only within the past two decades. Some discussion of the features indicated above may yield information or emphasis in support of the thesis set forth in these paragraphs.

Professional Organizations

Occupational medicine has assembled its own organizations and also its associations within other organizations in accordance with its internal functions and its external relationships. The membership rolls of the Industrial Medical Association and the American Academy of Occupational Medicine give mute testimony to the fact that nearly 4,000 American and Canadian physicians in the former organization have an active interest in some aspect of the practice of industrial medicine and that somewhat more than 300 physicians in the latter (most of whom are also members of the former) devote their entire professional attention to occupational medicine. The general concern of organized medicine in the United States is also expressed to some extent by the activities of the Section on Preventive Medicine of the American Medical Association and by the steady growth in the influence of the Council on Industrial Health within the American Medical Association. Something of the relationship of occupational health to public health has found its expression in the Occupational Health Section of the American Public Health Association. The American Association of Industrial Nurses and the American Association of Industrial Dentists contribute to the pattern of the professional teamwork in occupational health, not only through their participation in an annual Industrial Health Conference but also through official, informal, and individual professional activities in the interim.

Another professional organization, which is of major significance as both symbol and embodiment of the dual role of industrial (or general occupational) hygiene in observing man at work—observing man, the mechanism and the person, as well as the multiple components of his work environment, with the seeing eyes of experience and special skill of the physician and his associates in the biological disciplines and of the engineer and his associates in the physical sciences, fortified by their instruments of precision—is the American Industrial Hygiene Association, within

From The Kettering Laboratory in the Department of Preventive Medicine and Industrial Health, University of Cincinnati College of Medicine.

which nearly 200 physicians and about 800 engineers (using both terms in their broad meaning) maintain relationships comparable to those involved in their work. The potentialities of these relationships are beyond the scope of present vision, although some suggestion as to their probable direction will appear later. Suffice it to say here, that this professional teamwork in industrial hygiene, while not altogether unlike that in public health, is an essentially unique American contribution to professional performance in this field, extending as it does into the day's work, whether of research, of teaching, or of practice.

The last, but not the least important, of the organizations which must be mentioned in this context, is the American Board of Preventive Medicine, within which, as one of three affiliated specialties of equal status, occupational medicine has achieved formal recognition as a specialized field of practice. This came about in 1955, only after this form of medical practice had gone through a prolonged process of differentiation and had emerged from its empiric origin under the influence of a regimen of professional training which revealed its scope and mission in terms of the disciplines of which it is composed. Approximately 350 physicians have now (1958) been certified in occupational medicine, of which nearly 100 qualified for certification by passing a comprehensive examination. Some of the latter group had benefited by formal training, but the majority have had only the tutelage of experience, having cultivated their technical knowledge and skill at such times and from such sources as they could find. That this could be done is evidence of the quality of general medical education in familiarizing the studious and alert physician with the sources of professional information, as it is proof of the adaptability, resourcefulness, and tenacity that are in the best traditions of the profession.

Facilities for Research

At the turn of the century and for a quarter of a century thereafter, the facilities for research in matters related directly or closely to occupational medicine and industrial hygiene in the United States were few, and the total resources in space, equipment, and trained personnel were so meager as to be almost negligible. Specific diseases of occupation and specific problems of industrial and public health which arose out of the new and expanding industrial technology soon claimed the attention of investigators in governmental circles, industries, universities, and private hygienic agencies and organizations, and, with pedestrian progress at times, the march of research, as the primary source of professional knowledge, has taken its course. This course has failed to keep pace with the explosive development of industrial technology, but it has been drawn into the wake of that remarkable phenomenon, which is so firmly based on applied research, and from the latter it has taken much of its pattern. Its resources in laboratories and equipment, large and small, are now extensive, and are growing, as funds are made available by enlightened industry and by a government which is striving to meet its own responsibilities in research and to catalyze corresponding and complimentary activities in universities and other institutions of learning and investigation through contracts and grants-in-aid. The advance of medical and hygienic research in industrial health is being retarded by the dearth of well-trained medical and technical personnel—a dearth which is augmented by the more audible demands of other medical research and by the greater and more immediate rewards in the fields of industrial development and production. The latter factor is being offset, in some degree, by a growing recognition on the part of industry of the strategic role of educational institutions in maintaining and increasing the supply of trained teachers and investigators, but the pinch of scarcity persists as a threat both to the quality and to the quantity of institutional research in occupational health. Nevertheless, despite the disparity between the growth in technologic production based on research and that of a similarly derived technology in occupational hygiene, the progress of the latter, in the absolute sense, has been rapid and impressive, while the growing community of interest in research among responsible representatives of industry, government, and the professions involved in occupational health at this point in time is its most encouraging feature.

Periodicals and Reference Works

In the year 1919, the first monthly journal to devote itself exclusively to occupational hygiene appeared on the American scene. This, the *Journal of Industrial Hygiene* at its origin, has survived and maintained a distinguished career through a series of changes in name and, as the *A.M.A. Archives of Industrial Health*, is now published by the American Medical Association. It has shared the field for some years with another monthly journal, now entitled *Industrial Medicine and Surgery*. Meanwhile the official publication of the American Industrial Hygiene Association, the *American Industrial Hygiene Association Journal*, has

developed into a highly useful and respected technical and professional journal. The latest addition to this list of periodicals appears now in its first number, to fulfill the need of the Industrial Medical Association for its own voice in occupational health—a voice which speaks to many physicians who devote some portion of their time to industrial medical practice, as well as to others engaged therein exclusively.

In keeping with the development of American contributions to the periodical literature of occupational medicine and hygiene, professional and institutional libraries have been enriched by reference works and monographs to which student and practitioner may turn with profit, and in the assurance that their need, while not fully met, is in process of being fullfilled. Some concern is expressed from time to time with the fact that there is no general work or textbook which combines the art—the point of view and its specific applications to personal and socioeconomic factors—and the science of occupational medical practice with suitable, factual, reference material in both areas. Some awareness of the problem presented by keeping such a work abreast of the kaleidoscopic shifting of the technologic scene may suggest to the prudent that the periodic journal is the proper place for the publication of current ideas and results, and that the monograph, which deals exhaustively with one problem or with one aspect of the situation, is the most satisfactory form of comprehensive information for the student.

Professional Training

The disciplines of occupational medicine, along with some special features of clinical medicine, which relate mainly to the particulars rather than to the familiar principles of diagnosis, have to do with the medical aspects of occupational hygiene. The latter is concerned with the total environment in which various occupations are pursued and with the impact of environmental factors, especially those born of industrial technology, upon both individuals and groups of individuals over both brief and prolonged periods of time. Any satisfactory approach to the solution of these problems on the part of a physician who is the hygienic supervisor — the health officer — of those who work in some recognizable unit (or group of units) of production, service, or commerce requires (1) a fair grasp of the social and economic factors that enter into the structure and function of an industry (and of an industrial society) ; (2) a sound understanding of the technical processes and of the manner in which the employees do their work; (3) some knowledge of the methods and apparatus for the appraisal of specific components of the environment; (4) a fund of information as to the effects which may be exerted by these components upon human health and well-being; (5) an easy familiarity with the sources of information on such matters; and (6) competence in the gathering, recording, and utilization of individual and collective data that pertain to the qualities of the occupational environment and the reactions thereto of those who work within it. In short, the competent physician in the field of occupational medicine must combine clinical knowledge and skill (the capacity to deal satisfactorily with an individual patient) with the ability to apply effectively the principles and techniques of biometry, epidemiology, and preventive medicine (the capacity to reveal and interpret the reaction of groups and to apply preventive measures) and to do all of this on a background of social understanding that will enable him to maintain his professional poise in the midst of varied and often conflicting activities.

The primary educational problem is that of focusing the attention of the physician, at whatever stage of conventional medical training he may have reached, upon the urgent task of preventive medicine in industry, not as one of the concerns of the agencies and practitioners of public health, but as a productive and satisfying field for the private practice of medicine. The traditional focal points of advanced conventional medical education have been elsewhere, as almost every well-trained physician of our time knows and feels, with a justifiable pride in his skill. Thus, only such training as will provide him with comparable skill and a respected place among his colleagues will attract the earnest or sophisticated student of medicine in his undergraduate, graduate, or postgraduate years. Therein is found the significance of the development and the formal recognition of graduate training in occupational medicine. Such training is now offered in conventional form in several approved schools of medicine and public health in the United States, and such is the interest in the field in a number of other centers of medical and hygienic education, for both the medical and the nonmedical professions involved in occupational health, that additional opportunities and sites for satisfactory training may be expected to develop in the near future. The demand for graduate training in occupational hygiene is now greater than present facilities can meet, and although there is no corresponding or realistic demand for postgraduate train-

ing, the latter will certainly come in due time, especially if viable seeds are planted in the undergraduate years of medical education.

The Prospect Ahead

The progress noted in the preceding paragraphs, while heartening to those who have labored in bringing it about, should not be viewed in the roseate light of a complacent or irrational optimism. The fact is that the adaptations of medical research, education, and practice to the contemporary needs of an industrial and urban society have come late and are grossly, distressingly inadequate. They represent little more than the demonstration of a pattern of professional activity which is incomplete in itself and is but little used by scientists, educators, and physicians to meet the hygienic problems of our time. A few facts should suffice to reveal this simple truth.

The technologic era which has brought to America an extraordinary productive capacity and a remarkably widespread distribution of things which make for man's comfort, convenience, mobility, and leisure, has brought with it, stepwise, many new hygienic problems and many old ones in new guise. "It can be said without extravagance, that the most active immediate factors in the daily environment of the average man, and, even more pertinently, in that of the average workman in office, factory or farm, are not those provided by nature, but those created by man." Some sixty-odd million persons in the United States work in industry. These "workers" make up a very large proportion of our population, for most Americans are now employees, even the officers of industrial corporations. Most of us work for a living, and whether we work with back and arm, or with the observing eye and the trained mind, whether with transport vehicles, earth movers, machine tools, instruments of precision, apparatus for communicating the spoken or written word, or equipment for making calculations at lightning speed, we carry on daily in the midst of a complexity of motion, sound, light effects, machinery, and radiant energy that beggars description and baffles physiological analysis. Out of this welter of activities come physical and mental wear and tear, physical injury to sense organs, limbs, the skin, and the internal organs of the body, individually and collectively. Death occurs through overt accident and occupational disease, and it seems highly probable that life is taken away in bits and pieces from its potential span by frequent, almost daily, individual and collective subliminal insults. Throughout the centuries, man has been called upon frequently to risk his health and life itself in wresting a living from the land, the sea, the workshop, and the mine. But never before in the history of nations or of men has the ordinary man—a large proportion of a national population—been so surrounded by such a multitude of obvious, as well as unexplored and insidious, dangers. The physical background of modern industry (and of modern life) is something new under the sun—an environment made by man, which, in the making, has taken so much of his total time, effort, thought, and ingenuity as to leave very little for learning what might be its ultimate effects upon himself.

Until recently, the medical and sanitary sciences have been represented but scantily among the personnel and facilities of industry, and the great proportion of American industrial organizations today, especially the preponderant, small units, operate almost entirely without benefit of expert guidance in preventive medicine and industrial hygiene. Moreover, medical and hygienic research have explored only the surface of the industrial environment, and medical and sanitary educators, for the most part, have failed to recognize, much less to keep pace with, its existing hygienic problems. While, after highly successful experience in dealing with other, admittedly important, hygienic matters, American medicine and engineering wait to ponder, to muster trained personnel, and to debate how the latter may be deployed in greater numbers and in a more effective manner without upsetting long-standing traditions and conventions of practice, these problems grow in number and variety, and draw within their orbit an increasing proportion of the manpower of the nation.

Only a minute proportion of our industrial organizations have valid medical information concerning the health of their employees, while the composite picture of the state of health of our general industrial population does not exist even in rough outline. The frequency of occurrence of occupational disease is unknown, partly because of the lack of suitable mechanisms for reporting and assembling such information, but principally because the large segment of our industrial population is not under such medical supervision as would provide the raw data. Thus we do not know, and have no present means of knowing, just what has resulted from the profound changes wrought in the environment of the day's work by modern technology. As these changes progress in their complexity, how are we to know where they are taking us, hygienically, unless we secure means for examining them closely, develop suitable methods for their qualitative and quantitative appraisal, and equip ourselves to understand their effects?*

A highly conservative estimate would grant the existence of more than 100,000 industrial plants in the urban centers of the United States, not to mention many others in small cities, towns, and rural areas. These, for the purposes of preventive medicine and industrial hygiene, are served by some three or four thousand (probably fewer than two thousand in industrial practice exclusively), with vari-

*Quotation from a recent address of the author.

able degrees of experience and interest, and by a somewhat greater number of industrial hygiene and safety engineers, whose capacities for utilizing the professional and scientific armamentarium vary widely. Some thousands of other physicians devote more or less of their time, but only their conventional (diagnostic and therapeutic) skills, to industrial casualties. There are also many technically trained persons in industrial organizations who have developed a noteworthy ability to recognize and to eliminate or attenuate the worst and most obvious health hazards of industrial operations. These "amateurs" in industrial hygiene technology may not be ignored or regarded contemptuously by their professional counterparts in medicine or hygiene, for, by reason of the dearth of trained professional personnel, to them must go the credit for much of the quality of industrial performance in matters of safety and hygiene. This quality is far from being the best that could and should be realized, but it has served to reduce the severity of common forms of occupational illness and disease, if not to prevent them.

It is not intended that this discussion should disregard or belittle the contributions made, or to be made, by federal, state, or municipal health agencies and professional personnel to the health of the working population. Despite, or perhaps on account of, the American political philosophy that government should limit its functions and services to those which the people cannot (or do not) perform for themselves, the federal government has led the way in the past and promises to do so in the future in conducting and supporting research and in the dissemination of information and advice in matters of industrial hygiene. Certain state and municipal agencies have provided professional guidance and supervision within industry, and, through regulatory mechanisms, have reduced the hazards of industrial operations. All the states have adopted laws providing compensation for occupational injury or disease or both, and these laws have exercised some degree of economic compulsion in the direction of health and safety. By all such means, and by others which need not be recounted, the toll of life and health in American industry has been reduced somewhat, but not near to the point which can be reached by the direct efforts of industry in behalf of its own employees. If evidence is needed in support of this statement, it is available, if not for the record, within professional circles, in consequence of the experience of certain industrial organizations whose responsibility and foresight have provided examples. Therefore, the means by which the maximum of industrial health should be sought in the United States is not in serious question. Rather, the question is whether the broad responsibility for solving the problem can be assumed and met by industry, with ample private professional guidance and service or whether it will fall to the lot of government. By one means or another, or, better, by combined forces, greater efforts must be made, and soon.

The first requisite of any realistic effort to assess and control occupational hazards and stresses is that of recruiting professional personnel and providing them as promptly as possible with the training that will give them competence for their work. Greatly increased numbers of variously trained persons must be enlisted to conduct the basic, as well as the current utilitarian investigations without which the bulk of professional instruction and practice is destined to be futile. Many educational institutions will need to combine research and field investigations with both comprehensive and technical instruction in the several complementary disciplines and techniques of occupational health; training equivalent in quality to that of graduate training in other professional and technical fields must be provided, and the opportunities afforded for such training must be able to compete for a share of capable and dedicated minds. For the present, vigorous efforts along these lines, if measurably successful, cannot fail to advance the cause of industrial health, in view of the absolute scarcity of heads and hands of the entire field and all its parts. Sooner or later, however, and the sooner the better, the strategy of the efforts of recruitment and training will have to fit (or modify) the dynamic fabric of professional life in America. If the pattern set by our most effective industrial organizations in protecting the health of their employees is to be followed by only such industries as are engaged in obviously hazardous undertakings, at least ten physicians are needed in industry for every one that is now spending his full time in such service. Is it likely that a fourth of the physicians of the country (who now number about 210,000) can be persuaded to enter this field of practice within another generation? Certainly not without great efforts within the profession, within educational institutions, and within industrial management. Or alternatively, is it within the realm of possibility that a large proportion of the men who will enter upon medical careers within the next generation can be so trained as to be capable of dealing effectively with the hygienic problems of industrial organizations to which they

will give part of their time? Not without significant changes in medical education, and especially those changes required to provide effective instruction in preventive medicine. To a large proportion of American physicians and medical educators, these questions will appear to be unrealistic, although the mathematics involved in the implied estimate of present needs is simple and self-evident. If these questions cannot, reasonably or even optimistically, be answered in the affirmative, it becomes evident that the medical profession is not prepared to accept the responsibility for the direct handling of the problem of industrial health and that some other means of dealing with it will have to evolve out of the necessities of the situation or be put forward to meet oncoming developments.

Certain alternatives suggest themselves as possibilities. One of these arises out of the impressive progress of the technology of environmental appraisal and control in the hands of the industrial hygiene engineer. Given the specifications of a safe industrial environment, the techniques of engineering can go far toward securing the safety of men who work therein. In this coordinated effort, the investigators in what are designated as the medical sciences (which are often pursued by scientists who are not physicians), along with some physicians in industry, have provided the specifications which industrial hygiene engineers have undertaken to fulfill. While the physician in industry is (or should be) the final critic of the outcome of the engineering effort, it may be that his efforts can be distributed over a much wider area of industry than seems now to be possible. It must be recognized, however, that if the services of physicians in industry are to be reduced to a minimum, in acceptance of their numerical limitation, there must be a corresponding increase in the numbers of industrial hygiene engineers within the industrial organizations of the country. That the tangible and intangible rewards will be sufficient to divert technical and scientific personnel into this professional channel in sufficient numbers is but little more certain than that adequate numbers of physicians can be so recruited.

Another possibility is that the general pattern set in certain other countries, notably Great Britain, in establishing the system of medical and lay inspection of factories may find its American counterpart in the supervision and regulation of industry, in hygienic matters, by the individual states. That this could be achieved through the provision of adequate funds, the acquisition of sufficient members of trained personnel, and the development and maintenance of a high level of professional responsibility and competence within such a state service seems not impossible. Just how the personnel for such service would be recruited and trained; just what, ideally and practically, would be the professional representation in such governmental agencies; and what economies could be effected in accomplishing the task in an effective manner are matters which are no more assured than others which have been queried. This is not to suggest that certain states have not exerted a beneficial influence upon industrial health within the limits of their authority and their resources. To the contrary, the example set by some states, as well as the administrative and technical experience gained by them, could serve well to point the way for other industrial states. It is significant, however, that within the states that have the most extensive governmental facilities for advising and regulating industry in matters of health, many industrial organizations maintain their own programs of industrial medicine and hygiene. This is a sufficient answer to the postulate that a governmental agency is likely to have the facilities required to deal adequately with the problem. A sovereign state has the duty to its citizens of providing at least the minimum of services that may protect their health. On the whole, however, if responsible citizens are unaware of their danger or insufficiently concerned to take appropriate steps on behalf of themselves and their neighbors, it is unlikely that they will pay for such services through taxation.

The alternatives suggested above seem not to be entirely satisfactory, on the one hand, nor, on the other are they more likely to be put into extensive and effective use than is the hygienic regimen which has been tested by experience in some industrial organizations. The best hope for industrial health in America lies in the logical extension of the valid achievements recounted early in this discussion, so as to give adequate coverage within and throughout American industry. The fulfillment of this hope seems distant and a bit improbable, requiring more of faith, persuasion, and unremitting effort than seems likely to be put forth in our time. However, the tremendous persistence and ingenuity which have enabled man to penetrate the secrets of nature and to apply his knowledge for his greater wealth and comfort, when directed toward subduing the threats to life and health which his efforts have released, may well find defensive measures which, if not precisely those now envisaged, will assuredly be as comprehensive and effective.

Newer Concepts of the Pathogenesis of the Pneumoconioses

THE 1958 RAMAZZINI ORATION

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THAT DUST could be responsible for lung disease was mentioned first by Georgius Agricola[1] in "De re metallica" in 1557. His concept was that it had a "corrosive" action on the lungs. In 1700, Ramazzini[2] recognized that dust was a factor in causing miners' asthma. He wrote, "Confined air, saturated as it is with particles highly injurious to the lungs, brain and spirits, brings about a standstill in the blood mass and the spirits, and lo! a troop of maladies in arms." With Ramazzini the reaction was more than a simple mechanical one. In addition, there was a mysterious something which attacked the brain, spirits, and blood mass.

At any rate, the direct mechanical effect of sharp and pointed quartz particles on the lining of the lungs was thought for hundreds of years to be the cause of lung disease in miners. Zenker,[3] who first used the word "pneumonokoniosis," in 1867, believed that the abrasive effect of sharp particles was responsible for miners' phthisis. It was not until the work of Gye and Kettle[4] in England and Gardner[5] in the United States, only a little more than 30 years ago, that it became recognized that the mechanical theory no longer was tenable. It was primarily the classic experiment of Gardner (1923), showing that carborundum dust did not produce fibrosis in nontuberculous animals, which finally gave conclusive evidence that another theory of causation of silicosis must be sought.

The silica-solubility theory showed promise when Gye and Purdy[6] found that silicic acid and colloidal silica are toxic to tissues. When it was later shown that silicic acid goes into solution in small amounts from the surface of quartz crystals retained in lung tissues, it seemed reasonable to assume that it was this silicic acid which is the fibrosis producer. However, there never was very convincing correlation between solubility and pathogenicity with different types of free silica. Even King,[7, 8] who had been the strongest proponent of the solubility theory for many years, had acquired doubts as to its validity by 1956. Also, it never was clearly shown just how the dissolved silicic acid actually caused fibrosis, either in the form of nodules or in the form of massive hyaline fibrosis.

A number of alternative theories have been proposed from time to time, most of which have not received support from other investigators and have been largely discarded. The immunologic approach, however, proposed by Vigliani[9] recently is arousing increasing interest and will be presented in a future issue of this journal. It will be assessed with some detail later in this discourse.

Another "newer concept" requires discussion first. Until the studies in bituminous coal miners by the British Pneumoconiosis Research Unit, it always had been assumed that miners who developed nodular or massive fibrotic lesions must have had exposure to crystalline free silica dust in addition to the coal. It is quite evident now from the British studies that while some of these miners do develop silicosis, those with fine x-ray nodulation seem to have only focal collections of coal dust without any silicotic fibrosis and those with progressive massive fibrosis have coal dust retention plus tuberculous tissue. Coal dust retained in focal areas

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still seems to be a benign nonfibrogenic condition in coal miners who do not have associated bronchial disease and emphysema. This is clearly evident from the clinical studies of Gilson[10, 11] and his co-workers in Cardiff. Miners with coal retention seen by x-ray as categories 1, 2, and 3 show little if any more breathlessness or more impaired lung function than do nonminers at the same age levels. Moreover, their mortality rates were no higher than those of nonminers or miners with no x-ray evidence of dust retention. Actually, old miners without x-ray evidence of dust retention seemed to have a greater proportion who were short of breath than those who were classified as categories 1, 2, or 3, or than nonminers in the same community, particularly in the fifth and sixth decades. The reason for this apparent discrepancy was not apparent from the studies done so far and needs further investigation.

It happens that I had an opportunity through the courtesy of Dr. Gilson and his staff to review these cases in Cardiff last year; i.e., those miners without x-ray evidence of coal dust retention who said they were short of breath and who had lower than average ventilatory function figures. It was my impression from the x-ray films alone that the majority of the miners in this group had sufficient emphysema to "blot out" their fine micronodulation due to coal dust. This suggests that their incapacity is due to chronic bronchial disease plus emphysema. In other words, when a coal miner without conglomerate fibrosis becomes disabled, chronic bronchitis and obstructive emphysema are the most likely causes of the disability and not his coal retention per se. Gilson agrees that this undoubtedly is true and that Gough's and Heppleston's[12] type of focal emphysema, which is essentially a dilatation of bronchioles, probably is not responsible for any significant degree of impaired lung function.

This concept of the pathogenesis of coal workers' lungs is of more than academic interest. If the essential pathologic changes were dilated respiratory bronchioles, then bronchodilator drugs would have no place in the therapy of this condition. Motley[13] and many others, however, have had good results in treating breathless coal miners with various forms of bronchodilation. Undoubtedly, the principal disabling pathologic change in disabled coal miners is the old garden variety of diffuse obstructive emphysema, with which reversible bronchospasm frequently is the main feature.

If we accept the British thesis that coal miners can develop disabling emphysema without x-ray evidence of pneumoconiosis, it then becomes necessary to establish proof that there is a greater prevalence of such emphysema in coal miners at each age level than in nonminer males in the same community. The random samples of miners and nonminers in three communities were studied by Cochrane and Gilson[11] with questionnaires on respiratory symptoms and with lung function studies. In the age group 55 to 64, the average ventilatory capacity of nonminers appeared to be significantly higher than that of the miners without x-ray evidence of coal retention. We have not had such studies in any United States coal mines, and so we have no idea whether our soft coal miners without conglomerate fibrosis have any more disabling emphysema than do nonminers at the same age levels. As a matter of fact, we have no reliable figures on the incidence of disabling emphysema in the general population at the various age levels, information which is also urgently needed.

When one searches for explanations as to why Welch coal miners without massive fibrosis have more respiratory disability than do nonminers at the same age levels, one runs into difficulty. Coal dust per se is an inert material when injected into animal and human tissues. That is readily admitted by the British Pneumoconiosis Research Unit workers, yet Gough and Heppleston[12] feel that the peribronchiolar deposits of this inert material have some effect on the smooth muscle in the bronchiolar walls, causing the bronchioles to dilate. Functionally, however, the tests on coal miners who are disabled generally show obstruction of the airways rather than an increase in the dead-air space. If the obstruction is due largely to reversible bronchospasm and thick mucus, then the pathologist is seriously handicapped in arriving at a proper explanation.

This brings us to the question of whether or not heavy exposures to dusts other than coal over a period of many years could have a similar emphysema-producing effect. Heppleston, in a personal communication, stated that he had clear evidence that this was not a specific property of coal, and that hematite, coke, flue, and carbon black dusts have been shown in his laboratory to produce precisely the same pathologic effect. Both Gough and Heppleston agree that the dust concentrations necessary to produce focal emphysema must be extreme over a period of many years and that moderate exposures will not cause it. In my discussions with Professor Gough, I have told him of our experience in a number of occupations with extreme dust concentrations, such as iron oxide fumes in welding, burning, and grinding, koalin dust, and cement dust.[14] Concentrations up to

2,000,000,000 particles / cubic foot have been found occasionally with these jobs; yet we have not seen any kind of emphysema with such exposures. Gough pointed out, and this is quite true, that we have not made the same painstaking search for focal emphysema in lung tissue sections, using Heppleston's third-dimensional method. It also is true that not enough workers with these heavy nonsilica dust exposures have had lung function studies. Of one thing I am certain, however, from my own experience, arc welders, gas cutters and burners, and grinders of iron and steel who have x-ray evidence of iron retention, or siderosis, have normal lung function and no evidence of any type of emphysema. I also am reasonably certain that cement and kaolin workers who do not have conglomerate fibrotic lesions in their lungs have good pulmonary function, but they have not had complete function studies as a group. These at least appear to be truly benign pneumoconioses.

So much for the simple pneumoconioses, with or without emphysema. What about conglomerate fibrosis, or, as the British refer to it, progressive massive fibrosis? Do we have a sound explanation as to why some workers with simple pneumoconiosis develop conglomerate fibrosis while others never do? With silicosis, it has seemed certain that the majority who develop conglomerate or massive fibrosis do so because of associated tuberculosis. The combined lesion is essentially a hyaline fibrosis with occasionally cavitation due either to tuberculous necrosis or to ischemic necrosis. The natural tendency of such lesions it to undergo slow contracture, resulting in increasing emphysema in the rest of the lungs. This, in turn, results in more and more reduction in the ventilatory capacity of the lungs.

It was generally accepted until recently that crystalline free silica always is a necessary factor with such combined lesions. The British investigators, however, have shown rather conclusively that the massive fibrotic lesions in coal workers can result from coal dust and tuberculous infection without any associated silica dust. This massive fibrosis often is hard and rubbery and closely resembles silicotuberculous fibrosis. It always develops on a background of marked coal retention. It also may result in cavities which are mainly ischemic and seldom due to active tuberculous infection. Because proof of associated tuberculosis usually is lacking in these cases, there has been a tendency to reject tuberculosis as a factor in the pathogenesis of progressive massive fibrosis. More recent animal studies by King,[15] however, seemed to show quite clearly that coal dusting of tuberculous animals resulted in massive fibrotic lesions which did not occur in nontuberculous animals.

Other still more recent studies by Gross[16] with R_1 tuberculous animals showed progressive fibrotic lesions with kaolin or china clay dust, as well as with silicon carbide and aluminum oxide dusts. This progressive fibrosis was not so marked as with the quartz-dusted animals, but it, nevertheless, was real. It must be emphasized, however, as Gross has done, that the dust concentrations in this study were extreme. Gross agrees that it is possible that lower concentrations would have no such fibrotic effect in tuberculous animals. Radiologically, kaolin workers have shown two distinct types of lesions: a fine discrete uniform nodulation which resembles a benign pneumoconiosis (normal root shadows) and massive conglomerate fibrosis with secondary emphysema. There have been practically no cases with clinically active tuberculosis. It seems quite certain that the progressive fibrosis cases were in workers who had had a tuberculous lesion plus extremely heavy kaolin dusting. Those with the fine discrete nodulation appear to have had focal retention of kaolin dust which was inert and in lungs which had had no tuberculous infection.

These findings of progressive fibrosis when tuberculous lungs are heavily dusted with coal, kaolin, silicon carbide, and aluminum oxide, dusts which by themselves are not fibrogenic, are causing much concern among those of us who have so firmly believed that crystalline free silica must be present in a dust to result in conglomerate fibrosis. However, it is necessary to recall the early animal studies by Gardner[17] with silicon carbide. In those early experiments, silicon carbide in the R_1 tuberculous animals caused a progressive fibrosis quite comparable to that seen in Gross' animals. At the Second Symposium on Silicosis, in 1935, Gardner frankly stated that the cause of this finding with such an inert dust as silicon carbide is unknown. It still is unknown more than 20 years later, but it is of interest that Gardner speculated in 1935 that alterations in the immune state of the body may be responsible.

As a result of this suspicion, a department of biochemistry was established at Trudeau Sanatorium. In a series of experiments by Scheel, Klemperer, and others,[18, 19] it was clearly shown that a film of protein can be adsorbed on the surface of quartz crystals and antibodies are produced when this quartz, coated with serum proteins, is injected into rabbits. However, this seemed to be a specific property of quartz crystals and antibodies did not result from

numerous other injected serum-coated dusts. While it appeared likely that the altered protein on the quartz particles could result in a foreign-protein reaction in tissues, the fibrosis resulting from nonsilica dusts associated with tuberculous tissue still did not fit into this pathogenic concept.

Vigliani, however, has produced evidence by way of kaolin that quartz crystals are not necessary to produce hyaline fibrosis in the presence of tuberculous tissue. The so-called "Freund adjuvant" used in experimental immunology, which is a solution of dead tubercle bacilli (or BCG), has a well-recognized booster effect on the production of hyaline fibrosis in animal tissues when associated with nonsilicious dusts, particularly kaolin. There seems to be little doubt that a modified antigen-antibody reaction results from such a combination. While a good case seems to have been made for the silicotic nodule and hyaline fibrosis due to crystalline free silica, one suspects that there must be numerous nonsilica dusts which adsorb tuberculoprotein strongly enough to denature it yet fail to cause fibrosis. Much more research is necessary before one can accept this concept as fact, but it is recognized as being a most promising one.

Another rather recent concept of silicosis particularly is that it may be classified as one of the collagen diseases. This was brought about by the observations of Caplan[20] that coal miners with rheumatoid arthritis had roentgen changes which differed materially from those of miners without arthritis. These Caplan changes were distinctive sharply defined round shadows which were rather evenly distributed in both lungs. Such lung lesions in arthritics who had not had dust exposure are extremely rare. The nodules were relatively large, often suggesting metastatic carcinoma. Pathologically, they were collagenous nodules with necrosis in the center and active inflammation at the periphery. They resembled tuberculous granulomas histologically but could be differentiated from them by the complete absence of acid-fast bacilli either by staining or by culture. Yet Gough[7] stated that coal nodules in microscopic sections appear to be quite independent of the rheumatoid nodules. Nevertheless, the dust and the rheumatoid arthritis apparently have had a synergistic effect in the production of collagen in focal areas in the lungs, which either does not do alone.

This possible relationship led to the hope that cortisone or other corticosteroids might tend to prevent the silicotic nodule from developing. After numerous animal studies by Gough, King, and others, it was found that freshly developing nodules were retarded and the formation of collagen in the lungs was inhibited to some degree. After fibrotic nodules had already developed, however, there was no material change in the nodules except for a slight reduction in the amount of fibrous tissue. Many studies still are going forward in numerous laboratories in this direction, particularly with corticosteroids plus the antituberculosis drugs, so as to try to prevent the progressive massive fibrotic lesions from developing. Some of the results of these studies may have considerable practical value.

In summary, it is obvious that much remains to be learned to explain the numerous reactions in the lungs to various types of dust, with or without tuberculous infection. Is there such a dust which can be called truly inert when retained in the lungs, no matter how heavy the exposure had been? Theoretically, drowning of the lungs with dust probably can occur the same as with water, but it is doubtful that such extreme dust concentrations actually exist in industry.

It seems reasonably certain that there are numerous dusts which are truly inert when inhaled in moderate doses, such as iron oxide, carbon, coal, cement, gypsum, marble, kaolin, aluminum oxide, and silicon carbide. The question, however, which requires more proof before it can be definitely answered is: Will these inert dusts in insulting doses over a period of many years result in disabling emphysema? Our English friends say "yes," that coal dust may do so in some cases. We say "we don't know" as far as coal dust is concerned until we have had well controlled epidemiological studies. Such studies must take into consideration many factors, including age, smoking habits, climatic conditions, other sources of bronchial irritation, etc. By and large, simple pneumoconiosis, due either to isolated silicotic nodules or to focal collections of inert dust, is a rather benign affair in the vast majority of cases. Even our British friends generally agree that that is true.

However, as you well know, the conglomerate or massive progressive fibrosis, with or without active tuberculous disease, may become markedly disabling. There is increasing agreement that seldom, except with heavy silica exposure, does this occur from dust retention alone. Generally it requires a background of tuberculous infection and this appears especially necessary for the nonfibrogenic dusts. It seems certain now that we must accept the premise that such inert dusts when inhaled in extreme concentrations can result

in hyaline fibrosis in the presence of tuberculous infection, possibly because of a modified antigen-antibody reaction.

With all of this maze of pathogenic concepts, it is interesting to speculate how Brother Bernardino would react were he suddenly exposed to all of this. While your guess is as good as mine, my wager is that he would say: "Get thee back to the working places and rid them of these highly injurious particles. Then it would not be necessary to carry on such theoretical discourses which in themselves tend to numb the brain and the spirits."

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The Practice of Clinical Toxicology in Occupational Medicine

Rutherford T. Johnstone, M.D., Los Angeles

IN a treatise on the birth and death of specialties, Galdston[1] observed: "Nor has much study been given to the generic phenomenon of specialism in medicine, that is, to the variety of determining forces which engender specialism in medicine . . . for surely it must have struck many a thoughtful person that the phenomenon of specialization, not merely in terms of specialties developed but as a dynamic experience within medicine itself, merits study and exposition." What follows in this paper is intended to be a study and exposition of a most singular specialism within a specialty.

Decreed by Law

The rise of industrial medicine in the United States was engendered by the passage of various workmen's compensation laws beginning 50 years ago. These laws imposed obligations upon the employer, the employee and the participating physician. Born of necessity and legislated into action, industrial medicine from its inception until shortly after World War I was devoted almost solely to the treatment of trauma. Pertinent to the profession was that portion of the acts which read, "a case is compensable when it is a personal injury by accident arising out of and in the course of employment." The determination of compensability of a physical injury rarely presented a problem, since the time and place of occurrence were almost always obvious. Diagnostic acumen was not strained and liability rarely denied.

Came the Evolution

With the advent and subsequent rapid expansion of industrial processes which utilized one or more chemicals, medicine in industry could no longer remain single of purpose or simple in scope. The exigency demanded a new type of practice, the paramount need being a comprehensive program of environmental medicine with major emphasis upon prevention. The extent to which this has been accomplished as well as its degree of effectiveness ranks second only to some of the historic achievements in public health. However, despite the best of control measures, occupational diseases do occur. Their recognition and disposition is the primary task of the clinical toxicologist practicing occupational medicine.

Multiphasic Training

In general medicine, including the specialties, a physician practices within an area of readily accessible knowledge. Even on occasions when the diagnosis of a clinical entity is initially obscure, obtaining aid is not difficult nor is the source of information distant from the physician's daily contact. In contrast, to attain competency in the diagnosis of an occupational disease, the clinician must extend his effort and interest beyond that normally expected of him.

It is especially advantageous that the background training of the clinical toxicologist be in internal medicine and that he continue his interest and education in that field. Occupational diseases mimic nonoccupational diseases, hence the importance of the differential diagnosis. Abdominal pain in one who has concrete evidence of abnormal lead absorption may be due to appendicitis, biliary colic, gall stones, kidney stones, duodenal ulcer, or other causes. Liver dysfunction is not necessarily the result of an exposure to a hepatotoxic agent, just as pulmonary dysfunction may not be the result of working in dusty trades. In short, these and other problems are not solved solely by the

principles of diagnoses as generally applied in internal medicine.

The internist who seeks to confine his practice to cardiology, pneumology, gastroenterology, or disease processes of other systems of the body may do so by continuing his education within the existing structure of medical education. But he who would specialize in clinical toxicology in occupational medicine must pursue his training in areas outside the traditional boundaries of medical knowledge. Discussions of some of these follow:

Industrial Chemistry—Webster defines chemistry as "the science which treats of the composition of substances and the transformation which they undergo." The term industrial chemistry is not in the dictionary. It is used here as a consideration of the composition and transformation of chemicals used in industry with regard to their potential toxicity.

Gaining a knowledge of the chemistry of industrially used materials is probably the most arduous task faced by one who would undertake this specialism. It requires a complete reeducation in basic chemistry as well as a continuing search for information regarding the composition of presently used and newly introduced chemicals. It is not expected of the clinical toxicologist that he readily perceive the end-product within the body of a compound represented by a long and intricate chemical formula, but he should be able to recognize the implications of the significant groups which compose it. This writer likes to compare this type of detection to that of picking out the criminal or criminals from the morning police "lineup." For instance, noting a CH_3NH_2 group in a formula, cognizance is taken of the presence of a primary amine. Knowing the irritant properties of the amino group, its presence in an alleged exposure can then be evaluated with regard to the clinical picture.

Despite an adequate knowledge of chemistry, one is confronted with certain difficulties not easily resolved. One of these is the secrecy residing in trade-name products. Too frequently neither the employer who purchased the product nor the worker exposed to it has any knowledge of its chemical ingredients. This situation compels the clinical toxicologist to seek information from other sources, even at times from the manufacturer located in a distant city. This may be done by correspondence or, in an emergency, by telephone. To be successful in obtaining necessary information, it is often advantageous to develop a friendship with the medical directors, chemists, or toxicologists of leading manufacturers. Most of these professionals attend national meetings concerned with industrial toxicology and should be met on a personal basis, after which friendships can be developed by correspondence. Experience has taught that this is a technique in this specialism worthy of pursuing.

Equally disturbing is the sudden appearance within industry of an entirely new chemical compound or the use of a chemical not previously considered to have any economic utility. Admittedly, nearly all of these have been subjected to animal experimentation or to clinical study, if feasible, to determine the degree of toxicity. Clinical information is often available from physicians at plants which manufacture a chemical in question, based upon observations of employees unavoidably exposed in the process. On the other hand, chemicals are often utilized for a considerable period of time before any information regarding their toxicity is available. Beryllium is an example of a substance which was brought into wide use without adequate knowledge of its toxicity. Today we are experiencing considerable difficulty in securing information on the clinical aspects of exposure to a number of the propellents. Here again, a personal acquaintance with the right people is vastly important.

Industrial Processes—The clinical toxicologist cannot function adequately in the field of occupational medicine unless he receives training inside industry. Again, this must be a continuing education because methods and materials are constantly changing. A complete understanding of any given process provides a foundation of facts to which can be added the clinical aspects of the case under study. This combination is basic to the diagnosis. In addition, the information gained from in-plant observation by the clinician often leads to the correction of faulty hygiene, and thus his activities become a part of the program of preventive medicine in industry.

It is to be understood that the in-plant education of the clinical toxicologist is not for the purpose of having him supplant the industrial hygienist. It is true that their interests may overlap but, except for one aspect, their functions are not similar. The industrial toxicologist is not expected to make instrumental calculations but only to make observational studies which include the use of the five senses and an inquiring mind. Merely strolling through a plant does not constitute a survey. One must seek an explanation for any activity he does not understand. If the answer is too technical, one must have it spelled out in meaningful terms. Most surveys should not be limited to observing a single procedure but should follow the entire process from the initial

steps to the finished product. In this regard it is of value to be able to read a "flow sheet."

The clinician who makes plant surveys a part of his education and who familiarizes himself with the industrial environment gains a peculiar advantage over the inexperienced physician in that he understands the jargon which workers apply to a task, a machine, or a chemical. Such an understanding creates an immediate rapport of considerable value at the time the worker is being examined—especially if the case is one of medicolegal controversy.

Space forbids a more extended consideration of the multiphasic training of the industrial clinical toxicologist except to point out that he should have experience in interpreting x-ray films of the chest beyond that ordinarily possessed by an internist. It is to be appreciated that most toxic substances of industry gain entrance into the body by inhalation. Unless one is fully cognizant of the substances that do or do not leave their imprint upon the pulmonary tissue, the reading of x-ray films of the lungs is often apt to be erroneous.

Collateral Information

In addition to the journals and textbooks dedicated to the subject of occupational medicine and industrial hygiene, there are other sources of information which the industrial toxicologist should utilize. Among these are textbooks on industrial chemistry, industrial chemical processes, the encyclopedia of chemistry, and a number of journals in industrial and engineering chemistry. Practically all the larger manufacturing companies (chemical, oil, plastics, aircraft, etc.) publish "house organ" publications periodically. It is desirable to be on the mailing list for these, for often from such a source is found advance information fortelling the advent of new chemical compounds or new processes. By such means one can be "on top of the situation" and thus avoid being caught unaware. Also, one should be on the mailing list of publishers of scientific works which deal with chemicals and processes, to be informed of the appearance of new books.

Disposition of Occupational Disease Claim

Having determined whether a given case did or did not "arise out of and in the course of employment" the several parties concerned should be informed of the disease in a written report. This should be in the narrative form similar to that generally used in the presentation of a case history. The report should end with a section designated as "conclusions," in which reference is made to special studies pertinent to the case or to plant surveys. All those factors upon which the final opinion was based should be reiterated.

It is lamentable that the legal and administrative forces of the workmen's compensation laws have in some jurisdictions fostered the practice that the physician to whom a case has been referred for opinion shall not discuss his findings with the worker-patient. There is no justification for this attitude, especially as it applies to the following type of case.

When a worker becomes ill and alleges that his illness is due to his occupational environment, he is almost always sincere in that belief. Certainly it is understandable that he could imagine physical harm arising out of exposure to clouds of dusts or from irritating vapors. When a worker entertaining such a belief is seen during his illness or shortly thereafter, there is usually as yet no medicolegal controversy. Whether the case subsequently becomes such depends to a considerable extent upon the medical consultant. If the consultant will spend some time discussing the case with the worker, and often with the worker's family physician, unwarranted legal action, with its attendant economic loss as well as the creation, on occasion, of iatrogenic disease, will be avoided. In the situation just depicted the clinical toxicologist serves best the worker, the employer, and the insurance carrier if he fulfills the traditional ideas of physician-patient relationship.

In contrast, the case seen months or more after the alleged onset of an occupational disease while in litigation is one in which the consultant's opinion is to be transferred directly to the referring agency.

Comment

The clinical toxicologist in occupational medicine should be an opener of numerous doors, many of which do not lead into the main corridor of medicine. Its practitioner is not a researcher but, rather, a searcher for facts. But recording facts is not alone sufficient. They must fit into a framework of sequence and consequence. This pattern can be attained best by utilizing the background of internal medicine together with the tools and technique described in this paper. The need for the clinical toxicologist in occupational medicine is great; the opportunity to practice as such on an independent consultant basis has been almost entirely ignored.

Brockman Building [14]

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INDUSTRIAL HEALTH
in industrial and nonindustrial countries
A COMPARATIVE STUDY

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INDUSTRIAL health deals with the health of the worker in industry. Work and working environment may influence health, causing accidents and occupational diseases. Most sick absence in industry is, however, caused by non-occupational diseases. Working conditions may be a contributing factor in such diseases and may also influence the health and working capacity of the worker, causing stress, strain, and fatigue.

Industrial health services are organized in industry to promote the health of the workers. Such services deal with prevention of occupational accidents and diseases as well as with application of the principles of general preventive medicine. Rehabilitation is carried out by such services. The extent to which medical care is provided by industrial health services varies from country to country.

The approach to industrial health services may be very different in industrialized and in nonindustrialized countries,* according to the author's personal experience, from working and studying in both types of countries. Of course, most experience in industrial health services is reported from highly industrialized countries, but it is not possible to translate and apply these experiences directly in nonindustrialized countries. The basic problems in industrial health may be rather alike all over the world, as the human being is about the same and occupational hazards in mines, steel industry, paper factories, textile industry, porcelain factories, etc., in different countries are similar. The practical solution of and the approach to the industrial health problems may, however, be very different in countries with different degrees of industrialization and different standards of health of the population, and it will be of interest to make a comparative study of the different ways to approach industrial health.

*The term underdeveloped countries refers to the economic development, closely linked to the degree of industrialization. In this study the term nonindustrialized is used instead of underdeveloped.

Industrialized Countries and Industrial Health

Concerning labor in industrialized countries a great part of the labor force works in industry, perhaps 30% to 40% of the labor force, corresponding to 10% to 20% of the population. The types of industries may vary to some extent from country to country, but usually there are mines, iron and steel factories, industry producing nonferrous metals, machine industry, textile, food, chemical, paper, porcelain, building industries, and others. Agriculture, forestry, and office work are usually not included in so-called industrial activities. The labor situation in many industrialized countries has for many years until recently been characterized by full employment, unemployment being a problem only in certain areas or for a time in certain types of industries. Industrialization has contributed, raising the national income of the country and the general living standard of the population, although very great differences in living standards can still be found within an industrialized country, in different areas, and different professions. The slum areas at the outskirts of many large industrial cities could be mentioned as an example of "underdeveloped" areas.

The development of industrialization during the last 100 years has called for a gradual development of occupational health legislation, as, for instance, the worker's protection act, its supervision and enforcement by the factory inspection and even legislation on compulsory industrial health services, in some countries, such as France. In other countries, as Norway and Sweden, the organization of industrial health services has been based on an agreement between the employers' federation and the

federation of labor unions in cooperation with the national medical association. Social security has been developed in many industrialized countries partly through legislation in order to create some financial security for the worker in case of accident, illness, pregnancy and maternity, unemployment, or old age.

The health of the population has been improved by raising the general standard of living as well as by the development of public health services and medical care plans at the same time as the industrialization. Vital statistics show in such countries a high life expectancy up to 67-70 years from birth, a low infant mortality down to 20-30 per thousand live births during the first year, and a reduced morbidity of infectious diseases and epidemics, as, for instance, tuberculosis, diphtheria, typhoid, and smallpox. During the same period the birth rate is usually going down, which, combined with the low infant mortality, will cause a change in the age distribution of the population with fewer children and young people and with more old persons. In many industrialized countries 10% of the total population will be over 65 years of age.

Industrial health is characterized by a generally decreasing frequency of accidents and occupational diseases and by increasing efforts to promote the general health of the worker. Accident frequency in many, especially large, industries is reduced through technical prevention and efficient safety programs including training of new employees (see, for instance, the annual reports of the National Safety Council, United States of America). Occupational diseases on the whole are reduced and the incidence is gradually getting lower, although from time to time new occupational diseases arise as new chemicals or new technical processes are introduced—for instance, berylliosis or asthmatic bronchitis from isocyanate plastic. One should, however, not be too optimistic about the successful prevention of occupational diseases; for instance, a recent study on silicosis in Sweden did not show the favorable situation that was expected. Although prevention of occupational hazards is still important, much interest is more and more devoted to human engineering and to the general health of the worker, studying absenteeism, and introducing programs for control of communicable diseases, nutrition, and health education.

Industrial health services, specially organized in industries to promote the health of the employees, have gradually changed the aim in highly industrialized countries. They now include not only prevention of occupational hazards but also, as far as possible, create optimal working conditions through human engineering in order to reduce unnecessary strain and fatigue.

The four main headings of industrial health services will be discussed in more detail.

1. Technical methods are used to evaluate and to prevent occupational hazards through industrial hygiene and safety programs. The application of human engineering to work and working environment is aiming at replacing heavy physical work by machines and reducing the strain on the human being as far as possible.

2. Medical health services are dealing with pre-placement examination in order to have proper placement in relation to the physical and mental demands of the job and the physical and mental working capacity and ability of the worker. Regular health examinations, earlier carried out annually on all employees, are now more and more concentrated on groups of people with a morbidity higher than the average or exposed to certain occupational hazards. The aim of the health examinations is to detect diseases at an early stage or to detect hazardous exposure before any disease has arisen. Health examinations may be carried out on workers exposed to occupational hazards as quartz dust (silicosis), lead, benzene, carbon monoxide, trichlorethylene or exposed to noise or ionizing radiation. Health examinations may also be carried out on groups, as top executives, old workers, and employees with high long-term or short-term absenteeism. During recent years much interest has also been devoted to mental health in industry and to human relations. Applied industrial psychiatry, psychology, and sociology have through research and field studies contributed considerably to the improvement of the results of industrial health services.

3. Medical care has been developed in very different ways in different countries. The need for organizing medical treatment by industrial health services has in highly industrialized countries been gradually reduced through the developments of medical care plans and the availability of medical care in the community through family doctors, and hospitals. In some countries, for instance, as in France, Norway, and Western Germany, the industrial health services include only first aid and emergency treatment. In other countries medical treatment is extended to cover accidents and occupational diseases, which seems to be the practice in many industrial health services in the United States. In other industrialized countries, as in Sweden and Finland, medical treatment is also extended to nonoccupational dis-

eases but mainly focused on diseases at an early stage, often without disability or sick leave. In Soviet Russia the industrial health services in many places of employment, especially in the large industries, include full medical treatment of accidents, occupational diseases, and nonoccupational diseases for employees and their families.

Whatever the practical solution of medical care for industrial workers may be, it is always stressed that medical treatment in industry must be carried out in close cooperation with other treating doctors, as family physicians or doctors of the hospital staff.

4. Rehabilitation as part of industrial health services has increased in importance during the last 10 years. Modern techniques have demonstrated the great possibilities of putting even seriously injured and disabled people back to work. Rehabilitation, at the beginning mostly dealing with replacing workers who have been seriously injured through accidents, has been extended to persons temporarily disabled by accidents and to the large group disabled by chronic diseases such as heart disease and tuberculosis, and to alcoholics. Experience has shown that psychological factors are often more important than the actual physical disability in deciding if and how the man can be put back to work.

Experience from industrial health services in industrialized countries comes mostly from such services in large industries. Industrial health services do not exist in the majority of small industries in most industrial countries with exception of France, where legislation on compulsory industrial health services in all undertakings was passed in 1946 and then gradually applied. In many industrialized countries, therefore, a great part of the industrial employees are still not covered by any health services, as they work mostly in small undertakings.

The important problems for the immediate future of industrial health in highly industrialized countries may be visualized. It is obvious that much effort will have to be expended to extend health services to middle-sized and small industries. The introduction of automation will probably change the demands of the job on the human being from the physical to the mental side. Younger workers may be employed and specially trained for the jobs with difficult mental demands on the human being in industries with automation, and industrialized countries may have to face a problem of retraining and readjusting groups of middle-aged workers for other jobs when automation has been introduced in industry on a large scale. The increasing use of atomic energy in industry will call for special preventive measures and training of workers.

Nonindustrialized Countries and Industrial Health

Concerning labor in nonindustrialized countries, most of the labor force is active in agriculture and only a small group of the population, perhaps 1%, is employed in industry. However, many of these countries are now in the stage of rapid industrialization with "five-year plans" transferring large groups of people from agriculture to industry. The situation will be still more complicated through heavy unemployment and through the rapidly increasing population; consequently the average standard of living is low. In spite of all these difficulties, occupational health and social security legislation in the form of accident and sickness insurance, etc., is being passed and gradually applied in several of these countries, as in India, the United Arab Republic, and Mexico.

The health of the population in many nonindustrialized countries presents many difficult problems in connection with short life expectancy, as 30 to 35 years at birth, and high infant mortality, as 100-200 deaths per 1,000 live births during the first year. A high morbidity is generally found, especially due to infectious diseases as tuberculosis and malaria, diseases from parasites as Bilharzia and Ancylostoma, epidemic diseases as smallpox, cholera, and dysentery, as well as malnutrition, anemia and vitamin deficiency. This situation concerning the health of the population may, however, change in a rather short time, in 10 to 20 years, owing to the use of modern methods of public health and preventive medicine, such as DDT spraying against malaria mosquitoes, mass examination and vaccination against tuberculosis. Such a rapid improvement of health can, for instance, be seen in Ceylon, where life expectancy has been considerably increased and infant mortality reduced during the last 20 years. Such an improvement of health will, however, force these countries to face the difficult problem of creating a balance between increasing population and overcrowding, on the one side, and increasing food production and cultivated area, on the other. Family planning and birth control will probably have to be added as an important and difficult problem for the future in these countries.

Studying *industrial health,* one should emphasize the very great difficulties that a country has to face when rapidly industrializing, transferring in a short time large groups of people, many of them illiterate, from agricul-

ture to industry. These people will have to adjust themselves to new work and working methods as well as to the new working group in industry instead of working earlier with members of the family on the farm. They will also have to adjust themselves to the new industrial community. Even if some industries will be very modern and built without the mistakes made in the industrialized countries during the last 100 years, the new untrained workers will be exposed to accident risks and other occupational hazards. The general health of the population with short life expectancy and high morbidity will necessarily focus the interest only to a moderate extent on accidents and occupational diseases, but more on such serious health problems for the industrial worker as tuberculosis, malaria, and malnutrition. The problems of housing and nutrition of workers will be very important.

Industrial health services in nonindustrialized countries are usually to be found in few large industries. The motivation for industry to organize such health services will be completely different from that in highly industrialized countries. In these latter countries industries are interested in health services mainly because they will reduce absenteeism and labor turnover as well as accident frequency and may increase production and productivity. The increasing social responsibility of management will also be of importance. In nonindustrialized countries with high unemployment, the labor turnover is even from the beginning very low, as for instance in many industries in India 1955 less than 1%. Absenteeism is of almost no importance, except for highly skilled workers. In case of 10% absence of workers the industry will easily offset this by increasing the number of employees by 10%. Legislation on introducing compulsory industrial health services is thought to be an unrealistic approach in many nonindustrialized countries because it will be very difficult or impossible at present to enforce such legislation. Almost the only motivation left is that management should feel social responsibility for the health of the worker. The examples of advanced and progressive employers then will be of great value.

In nonindustrialized countries with low health standards of the population industrial health services may act as pioneers in the field of health, improving and promoting the health of the workers. Thus some priority should be given to health services for industrial workers.

The four main fields of industrial health services are discussed in more detail.

1. Industrial hygiene, safety, and human engineering will be of importance and may have a good start, since many industries will be new and machines and equipment modern. It should thus be possible to apply industrial hygiene, safety, and human engineering from the start of the industry. Experience has, however, shown that accident frequency will be high and that accidents at work will be a serious problem in the beginning of a rapid industrialization. The introduction of a great many workers into industry without any experience in industrial work is probably the main cause of the high accident frequency. Safety protection on all machines and equipment, and especially safety education and instruction, will be of utmost importance.

2. Concerning medical health activities, *preplacement examinations* are very important because of the high prevalence of such conditions as tuberculosis, malaria, bilharzia, intestinal parasites, and malnutrition. Industries in one country reported some years ago that 10% to 15% of the workers showed signs of malnutrition. It will usually be sufficient to get a rough idea of the demands of the job, especially if it contains heavy physical work, for instance applying a rating method. Detailed and elaborate methods for job analysis and selective placement are at this stage not worked out, as other health problems for the moment have priority.

With a high morbidity rate in the general population and great possibilities of relapse of diseases or reinfection of tuberculosis, bilharziasis, ancylostomiasis, etc., *regular health examinations* are of a great value. Even examinations without any complicated laboratory methods will have frequent positive results in industries where according to reports, 40% to 50% of the industrial workers have bilharziasis and still more ancylostomiasis. Vaccination programs connected with preemployment and regular health examinations will be of great value in areas where epidemic diseases are common. Vaccination against cholera was carried out once or twice a year in a coal mining area, visited by the author, and BCG vaccination was in some large industries carried out on all new employees who were tuberculin-negative. Providing the employees with a full meal a day at low cost in the factory will be of greatest value to promote health in countries with a high incidence of malnutrition among the population. This can for instance be seen in many progressive industries in India, Egypt, and the United Arab Republic. Housing programs for workers in industry, preventing overcrowding of workers moving into industrial communities from the country,

will be of great importance to health. Programs to provide the workers with houses with two or three rooms and kitchen and sanitary facilities have been made in several large industries in nonindustrialized countries. If such programs are not set up, it may happen that a worker moves into the industrial community alone, leaving his family in the country on the farm. He may then live in one room with ten to twenty other persons, may contract tuberculosis in a year, be dismissed, go back to the family in the village, and then be a source of infection. Excellent programs of housing that will solve the housing problems for a great number or even for all workers in five or six years are going into operation in several places. The author has seen such programs finalized or in operation for instance in a chemical industry in Yugoslavia, in chemical and textile industries in Egypt, United Arab Republic, and in tea plantations, heavy industry, and textile factories in India.

3. Medical care usually is not restricted to first aid but includes in many industries full treatment of occupational as well as nonoccupational diseases. Sometimes it includes also hospital treatment at the factory hospital, but this will depend on the development of hospital and medical care programs in the country.

With a high morbidity in the population and the high prevalence of positive findings at preemployment and regular health examinations, it is very important that there be follow-up of these findings. The necessary medical treatment may not have to be carried out by the industrial health service itself, but this service should do the follow-up to ensure that proper action regarding medical treatment is taken.

4. Rehabilitation is, for practical reasons, difficult to carry out to its full extent in a country with serious unemployment, as it will then always be difficult to find work for partially disabled persons or invalids. It is therefore important not to put the aims in rehabilitation too high in nonindustrialized countries but, rather, to try to carry out what is possible with available resources in consideration of the labor situation. A practical aim may be to have each industry take care of the rehabilitation of its own invalids who become disabled from injury or disease during the work in the same factory.

Industrial health services in nonindustrialized countries in a stage of rapid industrialization will perform pioneer work, applying principles of occupational health as well as public health and preventive medicine in industry, solving at least the major health problems for the relatively small group of the population that so far is working in industry. Since it is possible to organize efficient industrial health services without too much difficulty and cost, especially in large industries, this should be given high priority in such countries. Industrial health services should be developed at the same speed as industrialization.

A few problems of industrial health in nonindustrialized countries should be specially emphasized. Accident prevention and safety will be of greatest importance, since most workers will have had no previous experience in industry. The knowledge and experience on occupational health hazards and their prevention available in literature and that presented at international conferences on occupational health and through the World Health Organization and the International Labor Organization should be utilized as soon as new industries are planned. Preemployment and the regular health examinations and the follow-up of positive findings will be of utmost importance. As medical care and hospital programs may not yet be developed to meet the needs of the whole population in nonindustrialized countries, it will be useful to organize medical care services in industries. Industrial health officers must in such cases try to avoid the situation that medical treatment will take too much of the time of the personnel and that preventive health services will not be developed to the extent desirable or needed. A program for control of infectious and communicable disease as well as intestinal parasites, etc., would be of great value. Nutrition and housing will be one of the major health problems of the worker in industry. The transfer of large groups of people from agriculture to industry will involve many problems of social adjustment of the worker to his working group and to the community. Problems concerning this social adjustment should be met at an early stage through establishing housing and community programs and through education. Sociological studies may be of great interest in following the process of adjustment and revealing the main difficulties.

The promotion of industrial health on the national level in nonindustrialized countries may meet many difficulties. The national government is usually trying to provide, in the same way as in industrialized countries, some minimum standards of hygiene and health at the working place. The principles and details of these standards are laid down in a worker's protection act and the corresponding regulations, and the enforcement and control of this legislation are carried out by medical and technical personnel of the factory inspection.

The main activity on a national level in the field of public health will naturally deal with the most important public health problems as control of epidemics and infectious diseases, such as tuberculosis, malaria, bilharziasis and other parasite-caused diseases, venereal diseases, and the like, and will also deal with the major problems of environmental sanitation, such as water and sewage treatment.

If only 1% of the population is originally employed in industry and the employees increase to 3% during 10 years of industrialization, it will be difficult to get a priority within the health services for the relatively small industrial population when the main public health problems for 97% of the population are difficult and the solution of these problems is urgent. Therefore, there will easily be a gap between the efforts to protect the workers against occupational hazards through factory inspection, etc., and the efforts to promote the health of the whole population through public health services. This gap has to be filled by organizing industrial health services. It may, however, be difficult on the national level to get priority for these industrial health services and to get their administration coordinated with the activities of labor inspection and public health services. The fact will also be cited that the income and standard of living of the workers in industry is higher than that of the majority of the population working in agriculture and that no priority should be given to a small group of the population as long as the majority has lower standards of living. On the other hand, promotion of the health of the worker in industry is of great importance for the national income, and thus for the country as a whole, and therefore should also be given priority.

In nonindustrialized countries rapidly industrialized and developing industrial health services there will soon be a great need for trained medical and technical personnel as well as for research and field studies, and organization of institutes on occupational health for training and research will be very important. The joint ILO-WHO Expert Committee on occupational health has in a recent meeting laid down plans and programs for such institutes of various sizes.

International Activities

Activity in industrial health on the international level has been of great value for the development of this field of medicine. The International Labor Organization (ILO) and the World Health Organization (WHO) have supported activities in industrial health through assisting institutes of occupational health for training and research, in providing fellowships, equipment, visiting lecturers, and other aids, and through organizing conferences and seminars on occupational health. The joint ILO-WHO expert committee on occupational health has since 1950 studied definition of occupational health, health in small industries, teaching, and training. WHO Bulletin had a special issue for occupational health 1955, reporting on important occupational health problems discussed at European Seminars in Leyden and Milano. ILO has recently (1956) issued "Guiding principles for the organization of occupational medical services in places of employment," and is now preparing a "Recommendation on organization of occupational health services in places of employment" for a second discussion and acceptance at the ILO conference 1959. The Permanent Committee and International Association on Occupational Health, a voluntary world-wide organization of experts in the field of occupational health, decided at its 50th anniversary meeting, in 1956, to emphasize especially the occupational health problems in nonindustrialized countries. Some problems and experiences were presented at the Committee's recent international congress on occupational health, 1957, in Helsinki, Finland, and will be continued at the next international congress, 1960, in New York, U.S.A.

Conclusions

From this survey it may be clear that even if occupational health hazards and the basic human problems may be similar in industrialized and in nonindustrialized countries, the practical approach to industrial health and industrial health services in the two types of countries will be very different. Experience from industrialized countries will certainly be of great value, but it will be necessary for the nonindustrialized country, considering the special problems of rapid industrialization, high morbidity in the populace, and transfer of large groups of people from agriculture to industry, to make its own program to fit in with the special situation in the country and to establish the necessary priorities in the field of industrial health. The industrialized countries may learn very much from the interesting development of industrial health services in nonindustrialized countries. An increased international exchange of experience during the present period of rapid development of industrial health all over the world will promote the health of the workers in industry on a world-wide basis.

Management of Trauma in Relation to Permanent Disability

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THE CONSEQUENCES of acute trauma may lead to death, permanent disability, or full recovery. In the management of acute trauma emphasis is usually placed on life-saving measures and the most adequate methods of treatment to relieve immediate distress. From the viewpoint of the injured person, saving a life that is threatened by shock often involves heroic measures and good surgical judgment. In the industrial field the ultimate problem is that of liability. Permanent physical impairment results in permanent disability. Compensation for loss of earning capacity often involves litigation. To the industrial surgeon, the end-result and consequences of permanent disability must be visualized at the beginning of treatment and its costly possibilities considered throughout the surgical management. This includes the rehabilitation period and observation until the patient can be declared dismissed as ready to resume some kind of gainful occupation.

Permanent disability in one form or another has reached a state of exceedingly great importance within the past few years due to the social and economic benefits which are provided by law. The cost in dollars is almost incomprehensible. Pensions for veterans, disability claimed under the provisions of the industrial compensation statutes, social security benefits for disability retirement, vocational rehabilitation provisions for handicapped persons, and innumerable forms of insurance claims have made a tremendous impact on the practice of medicine and surgery. It seems that almost every patient has a form to fill out and sign. Every doctor's office has become so burdened with the responsibility for writing reports or testifying in court that the physician has very little time left for treating his patients.

It is well to take a new look at the management of acute trauma in light of its basic responsibility for permanent disability. The challenge is both a responsibility and an opportunity because today we are in a position to do more to master the disabling effects of trauma and illness than ever before in history. Thousands are alive today who would have died under the medical and surgical facilities of a few years ago. There are the phenomenally successful life-saving measures in the fields of brain, heart, blood vessel, and lung surgery, together with better hospital facilities for emergencies. Many persons are less disabled because of advanced antibiotics and other "wonder drugs." Probably the two most potent factors responsible for the progress in treating acute trauma since the era of World War I have been the organized blood bank and the advance of antibiotics. Despite all these advances, many of the older conservative measures, such as thorough debridement of compound fractures and closed methods of reduction, have a useful field and should not be lost sight of in the teaching of the principles of treating acute trauma.

Shock

The treatment of shock depends greatly on efficient teamwork on the part of the ambulance service, the hospital facilities, and the surgeon. With mass disaster of atomic warfare threatening to become a reality at any moment, disaster teams should be encouraged by the systematic and efficient emergency organization demonstrated by the recent Bayonne

railroad wreck, in which a train plunged through a bridge into Newark Bay. There had been thorough preparation and rehearsals in simulated disaster so that administration, medical, and nursing personnel were promptly at their posts of duty ready to coordinate when reality came.

The management of shock should start at the scene of the accident. The first essential is the control of hemorrhage, the second is the avoidance of rough handling, and the third is early immobilization of fractures. Of course, the victim should be kept warm and relieved of pain. The blood bank, the administration of oxygen, and improved anesthesia have greatly reduced the incidence of shock. On arrival at the emergency room the extent of blood loss should be determined and the blood volume restored without delay. The phenomenon of shock is now looked upon as an "alarm response to trauma." When the normal functioning of a mass of protoplasm is suddenly interrupted through trauma, the entire nervous system and viscera respond with an alarming rapidity in direct proportion to the magnitude of the injury. The release of corticotropic hormones through the anterior lobe of the pituitary and the increase of epinephrine from the adrenals affect the body fluid metabolism, the urine volume, and the excretion of sodium and chloride; hence counteracting measures of increasing or decreasing body fluids and balancing the carbohydrate metabolism must be instituted accordingly. Although the supreme state of shock is of first importance, no time should be lost in making a detailed survey of every part of the body at the earliest possible moment. Serious and irreparable damage from complicating injuries may result if a certain amount of risk is not taken in their treatment even though the patient is in shock or is about to go into a state of shock. The spleen or liver may be ruptured. A fractured femur should be placed in traction immediately. A dislocation of the hip should be reduced as promptly as possible, otherwise there will be so much interruption of circulation through several days' delay that stretching of the torn capsule of the joint will produce aseptic necrosis. A cold foot and leg should immediately lead to the suspicion of rupture of the tibial or femoral artery. A few hours' delay in blood vessel repair means amputation. Failure to do a thorough debridement of a compound fracture within the first six or eight hours may mean a lifetime of osteomyelitis with draining sinuses and sequestra or a nonunion requiring repeated operations and bone grafting.

First Aid

The more highly organized industrial plants have accomplished great strides in educating their employees on the importance of safety and first aid measures. Constant reminders that even the more minor injuries, such as puncture wounds of the fingers and feet, must be reported and treated at once have prevented costly disability and increased working hour values. In general, competent early treatment of minor trauma is commonly neglected, especially in home accidents, and in the smaller industrial businesses, where many of the greater incidents of trauma occur.

The incidence of disabling injuries from automobile accidents in which trauma of every conceivable form is encountered, has reached over one million per year. Strangely, on-the-scene first aid is given but little concern; instead, the victim is madly rushed to the hospital —oftentimes without badly needed splinting of fractured limbs or back. Fate seems to choose the time and location of automobile accidents. Too often they occur in a remote place where the sympathetic care of passing motorists or curious observers is all the relief available until the ambulance arrives. Few motorists seem to be impressed with the importance of having simple first aid kits in their cars. Enthusiasm for Red Cross first aid training during the war periods rapidly diminished when the mass excitement of war was over; yet the fatalities and destructive results of severe trauma on the highways greatly exceed those of military action. A fatal automobile accident rapidly becomes just another daily obituary and an addition to the yearly death statistics. Publicity is nil on what preparedness through first aid training might have accomplished to prevent the fatality. Such interest remains only a speculation of the doctor or the undertaker. People are killed every day because the doors of their cars flew open on impact or collision; yet comparatively few have equipped their cars with seat belts. Automobile engineers consistently refuse to assume the responsibility of full safety designing. The Red Cross signs of war days indicating availability of trained first aid service have disappeared from the filling stations across the country. Efforts of the civil defense organizations have met a deaf ear from civilians as a whole. People with fractured necks or backs and hemorrhaging compound fractures are still being roughly handled or hastily loaded into ambulances or automobiles with little regard to the harm that might occur before reaching the hospital. Ignorance in the use of a tourniquet is appalling. Recently an onlooker

at an accident in which a man's leg was severely crushed placed his belt around the leg. When the ambulance arrived he removed his belt, and a tourniquet was not reapplied. The victim was almost bloodless on arrival at the hospital, and heroic measures were necessary to save his life. In another instance a man was stabbed in the neck and a bystander picked up a piece of rubber hose and wound it around his neck almost choking him to death before the doctor arrived.

If mass disaster from atomic warfare should occur, the many lives that could have been saved and the intense suffering that could have been relieved through first aid knowledge will be measured only as a disgraceful neglect of civilian preparation because medical aid and hospital service will not be spared in the destruction.

Debridement

Civilian injuries as well as the more explosive gunshot type of military wounds require debridement. Victims of automobile accidents are thrown out of the car into the debris of pavement and ditches. Thorough debridement of compound fracture wounds still is of extreme importance, even though antibiotics have greatly lessened the hazards of infection. Debridement should not be delayed over six to eight hours. Copious quantities of normal saline or just plain water should not be spared. A sterile field should be prepared and the rules of strict aseptic technique observed. In a compound fracture bone fragments should be removed sparingly and only when irreducible fragments are totally detached from periosteum. Removal of skin also should be restricted to only the soiled edges of the wound and portions that would become necrotic. Reduction of fragments is advisable but overenthusiasm in the use of internal metal fixation may do more harm than good. Old fashioned skeletal traction methods are hard to excel for prevention of infection and the assurance of union.

Primary Hospital Management

Patients with compound fractures, dislocated hips, serious fractures of the pelvis and spine, and shock-promoting deformities are still being put to bed as emergencies and their injuries permitted to go unattended because unconsciousness, shock phenomena, and other general factors are thought to be too serious to risk the necessary primary surgical procedures.

It is true that the general condition of the patient is of primary consideration and that injuries of the extremities have low priority in

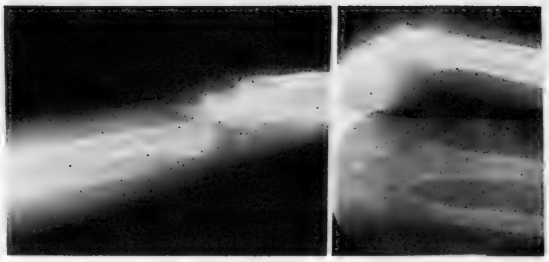

Fig. 1 Fig. 2

Fig. 1—Fracture dislocation of right wrist which would result in severe disability if not reduced early. Other injuries were compression fracture of 10th and 11th thoracic vertebrae and fractures of six ribs, accompanied by severe shock. Fig. 2—After closed reduction on the third day.

relation to serious injury to the internal organs. However, the invasion of sepsis does not wait on other conditions. Necrosis of tissue proceeds rapidly from pressure ischemia in severely displaced bone fragments, ruptured internal organs produce hemorrhage, and paralysis rapidly follows compressed nerves. No matter how serious the general condition of the patient may be, the results of loss of time from temporary disability should be evaluated and in many instances the extra hazard of prompt primary surgical necessities carried out.

A sodium pentothal anesthetic is often of benefit in the presence of shock. Time enough can always be allowed for preoperative blood transfusion, which can be continued during the operation. In desperate circumstances only should the primary measures most essential to prevent wound complications be postponed.

On the contrary, many severe fracture injuries occur that should not be rushed into surgery. An example of this point is the aged person with an intracapsular hip fracture; here, rest in bed with the leg in Buck's extension will be greatly beneficial to the shocked body tissues over a period of 24 to 48 hours. Many aged persons have never been in a hospital. A day or so may establish equilibrium to insure recovery from the effects of apprehension, inhibited elimination through use of the bed pan, and other objections to confinement in bed. The hip can be reduced and pinned just as well within two or three days as on admission, and proper administration of blood and other supporting measures will often prevent mortality from surgery.

Other injuries, such as Colles' fracture and fracture of the ankle, should be reduced as early as possible. Remote injuries, such as fracture of a metacarpal, a metatarsal, or a rib, should not be overlooked.

Ambulation vs. Bed Confinement

World War II reversed some of the rules of immobilization of World War I. The necessity for early ambulation and quick evacuation greatly reduced the use of the Thomas splint, suspension traction apparatus, and the plaster cast. The introduction of external skeletal fixation, intramedullary pins and open reduction with internal fixation became popular through the availability of antibiotics to prevent infection. It is now a recognized practice in all surgery of trauma to obtain early body ambulation and liberal joint function. This has resulted in a lessened incidence of thrombophlebitis, embolism, and ankylosed joints. Progress in rehabilitation measures has succeeded in impressing the fracture surgeon that rehabilitation starts at the time of the first treatment of the fracture.

The ideal objective in treating fractured bones is to obtain solid bony union in the shortest possible time with the fragments in good alignment and no shortening. The first of these objectives is the most important consideration. Of what use is the limb even with good alignment and not shortening if healing results in non-union? Even if union might eventually be obtained by bone graft, how long will total temporary disability exist? Internal fixation is often used in order to permit early mobilization, but if this method results in delayed union what has been gained? The engineering of fracture treatment often is based on no other consideration than that of the x-ray appearance of the displaced fragments. Plating or pinning of the fragments may appear simple and easy, but no open reduction is simple or easy. Local difficulties always arise to produce much more local trauma than expected. The unfavorable location of the fracture in relation to the blood supply, the multiplicity of fragments that will require extraordinary skill and much more surgery and metal than anticipated should cause the surgeon to reason carefully before choosing an open method of internal fixation in preference to a closed method of immobilization or efficient traction.

Open Reduction and Internal Fixation

Open reduction and internal fixation are usually decided upon for either one of two reasons: (1) absolute necessity and (2) the likelihood of achieving a perfect end-result. In cases in which open reduction is decided upon, it should be done within 24 to 48 hours for the best interest of the traumatized soft tissues. Delay until the blood clot becomes organized or until after the fragments are damaged from multiple manipulations is more likely to interfere with the physiological processes of union.

Some of the situations making open reduction an absolute necessity are the following:

1. Long pointed fragments that penetrate muscle tissue and obviously would not be controllable by closed methods.

2. Interposition of periosteum or soft tissue that will not permit engagement of the fragment ends by manipulation.

3. Fragments near the joint, such as condylar or malleolar fractures or fractures of the bone ends that disrupt the continuity of the smooth joint surfaces.

4. Evidence that nerves and blood vessels are injured may later become involved in the callus of irregular displaced fragments.

5. Fractures in which open reduction has long been known as the only method for reducing and controlling the fragments, such as fractures of the patella, olecranon process, head of the radius, Monteggia type forearm, neck, or intertrochanteric fractures of the hip, and oftentimes fractures of the shaft of both bones of the forearm.

Open reduction often may be the method of choice in order to obtain early ambulation: the use of the intramedullary pin for bone shafts, the hip nail for the neck of the femur, the angle pin for intertrochanteric fractures, the various types of bolts for the condylar fractures about the knee joint, the threaded wires and pins for fractures of the clavicle, phalanges, and metacarpals.

Closed Reduction

Successful results from closed methods of reduction actually require more skill, ingenuity, and patience than from open reduction. Of late years the popularity of open reduction and enthusiasm for use of the clever and more efficient devices for internal fixation have given rise to a loss of interest in many of the old reliable conservative methods of manipulation, splinting, and skeletal traction. Hasty and damaging surgery still is to be condemned. No matter how urgent the demand for lessening the hospital stay or other reasons, conservative closed methods should be given first consideration because it is well known that union is more definitely assured.

Even in Colles' and Pott's fractures, open reduction and internal fixation are being used. The x-ray appearance of the fragments thus may be made to appear good, but what of the end-result? The period of temporary disability is seldom shortened, and traumatic arthritis or other discouraging complaints may cre-

ate greater dissatisfaction than closed reduction with more respect for function and less interest in perfect alignment.

Skeletal traction may be obtained through the use of Kirschner wire and suspension traction or by pins above and below the fracture fixed in plaster while traction is applied on the fracture table. Roger Anderson external fixation methods are very useful, especially in compound fractures.

Some of the advantages of skeletal traction are these: (1) The methods are efficient and reasonably safe; (2) trauma is less than open reduction; (3) joint function usually can be provided for, and (4) compound wounds may be dressed frequently.

Emergency Treatment of Hand Injuries

Failure to recognize lacerated tendons in hand injuries is one of the more frequent causes of permanent disability. Others are improper splinting and overimmobilization. Too often a hand injury is approached as nonserious minor surgery. Emergency treatment is undertaken in the office or emergency room without thorough and complete preparation. A long and tedious operation results in contamination, inadequate exposure, and rough handling of tissues. Severe disability results where it might have been avoided.

It is often hard to decide whether to try to salvage or to amputate a finger. It is best to postpone amputation unless contamination and tissue destruction are so severe that there appears to be no possibility of function. Amputation can always be done later. Severe fractures of the phalanges or metacarpals should be treated with meticulous respect for accuracy. There should be no bowing or rotation of the bone shafts, and overlapping with shortening is to be prevented if possible. Internal sutures with wire often must be removed later. The use of small intramedullary or transfixion pins is preferable where they can be used efficiently. The common fault in various methods of traction is prolonged tension on the joint ligaments, which results in permanent limitation of motion.

Burns of the hands and fingers should receive early debridement and skin grafts where necessary for closure. Electrical burns deserve special consideration. Destruction of tissue may be more extensive than is at first apparent. It is best to await demarcation.

Splinting a finger in full extension as long as two weeks is very likely to result in stiffness that will not be overcome to the point of full flexion for at least four to five months. Many acute injuries of the fingers would heal without permanent stiffness and disability if early mobilization were provided.

Injuries of the Neck and Back; Whiplash Neck

The so-called whiplash injury has been brought to the attention of the public as well as the medical profession in a most dramatic fashion in the past three or four years. In many instances the physician is not responsible for inadequate early treatment because the injured person does not present himself for immediate examination and often neglects to consult his physician for a number of days. All too often when the patient does present himself with the marked subjective symptoms of stiffness and pain in his neck and arm with little or no positive objective clinical signs or x-ray change, very little is done for the relief of the patient except partially to support the neck with a semirigid collar or recommend rest and home treatment, hoping that the pain will soon subside.

The best treatment for sprained or torn ligaments about a joint is immediate and complete rest. Usually the patient thinks more or less lightly of his symptoms and will not consent to complete bed rest. The patient who is put to bed promptly and early after the injury is bound to secure satisfactory relief from his pain almost immediately. If he is kept at rest until the ligaments heal, which is at least a week to 10 days, the onset of arthritic changes and permanent stiffness can be prevented. Lack of positive clinical and x-ray findings in a whiplash injury should be no excuse to postpone complete, thorough rest in bed with properly applied traction until the symptoms begin to subside. Where a definite pathologic condition exists, such as fracture of the facets with or without subluxation or dislocation, the problem should be treated according to recognized surgical methods. Thorough treatment will largely eliminate the disabling symptoms of aggravated rheumatoid conditions and pain-producing injuries to the nerve roots. The patient who has been adequately treated promptly after the injury with complete bed rest and traction will be much less likely to develop the emotional reaction and neurotic apprehension which are often contributory to permanent disability.

Injuries of the Low Back

Many of the more complicated difficulties in determining permanent disability following a back injury are due to failure to give the injured person full advantage of immediate and complete rest in bed. A fall down the stairs, seemingly of mild immediate consequences, or

slipping in the bathtub with seemingly no severe injury, or a heavy weight striking the shoulders or head and causing neck or back pain should be considered as possibly more than a sprain for several days or even weeks. When an x-ray examination reveals a moderate compression fracture of a vertebral body, it is hardly controversial that complete rest in bed with moderate traction for a period of 10 days to 3 or 4 weeks is the best treatment. Every injury of the back severe enough to cause persistent pain day and night but relieved by complete bed rest should be treated continuously in bed for at least three weeks until the traumatized tissues have had an opportunity to reach early healing. Many cases of more or less mild injury and strains to the back superimposed upon preexisting conditions, such as osteoarthritis, rheumatoid arthritis, or developmental abnormalities, would be prevented if complete early bed rest were instituted immediately after the trauma or within a few days. On the other hand, long continuous immobilization of a patient with a back injury with plaster or steel bracing is likely to produce permanent rigidity, stiffness, and soreness resulting in permanent disability.

Rehabilitation Adjustment and Adaptation

In many instances the influence of adverse mental reactions to an injury of the body is of almost equal importance to the resulting disability as that of damage to the physical parts of the body. In the end, interpretation of the functional effects of the injury must include the patient's willingness and determination to overcome any physical handicaps he may have. Likewise what the individual thinks of himself, and what other people may think of him in light of his physical incapacity, will greatly influence his ability to readapt himself to his daily activities and his ability to stay on the job and work.

Great responsibility falls on the surgeon in treating an industrial injury in respect to the determination of the ultimate permanent disability. In the treatment of trauma rehabilitation begins with the early surgical treatment. The surgeon can have a wide influence upon the injured person by preparing his mind to accept any final disability that may result. Unfortunately, there are too many outside influences that begin to prey upon the mind of the industrial case about the time he approaches the rehabilitation and readjustment period to create emotional psychogenic reactions which greatly delay the return to work period. The claim adjuster, the employer, the consultations with the attorneys, union complications, and many other factors creep into the picture about the time the patient begins to recover. In comparison with an injured individual such as a farmer, who has only himself to carry the responsibility, the industrial case many times brings on an avalanche of investigation, physical examinations, court trials, and many other interfering factors which greatly delay readaptability to employment. In the early treatment of trauma the physician can help greatly to prevent some of these complications by preparing the mind of the industrially injured patient so that he may approach these delaying factors without apprehension. The chance statement by the physician magnifying the seriousness of the injury and probable disability, the early intrusion of the claimant's attorney, or the early approach by the insurance adjuster for a settlement, oftentimes transforms the course of more or less simple injury into one of great speculation as to the extent of actual disability. Multiple medical examinations and court hearings often give rise to conflicting opinions on preexisting disease and other factors which perpetuate anxiety, apprehension, false notions of gain, and other psychogenic factors that gradually transform a simple injury to one that eventually rates a severe disability.

Summary

Management of acute trauma is discussed from the viewpoint of preventing permanent disability. The surgeon should foresee his end-result possibilities at the beginning of treatment and constantly work toward minimizing permanent disability.

605 N.W. 10th St. [3]

Present Position of Government in Occupational Health

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IN THE U.S.A. we live in a highly industrialized society. This phenomenal development has been achieved with less governmental regulation and dictation than exists in any other industrialized country. Many Europeans find it difficult to comprehend how our industries can be clean, healthy, and safe places in which to work with so little specific governmental regulation of the work environment. The answer lies in the generally excellent job American industry presently is doing in building and maintaining clean, safe, work establishments and its ever-willingness to correct hazardous practices. Three potent facts impel American industry to establish and maintain clean, healthy, safe work places. In the first place. it is good business, resulting in less compensation costs, less absenteeism, less labor turnover, and greater productivity. Secondly, there is the secure knowledge that, should industry ruthlessly damage workers, government would act forcefully and the resulting imposed regulations might be difficult to live with. Thirdly, in recent years organized labor increasingly has introduced certain aspects of occupational health and safety into collective bargaining negotiations.

An obvious reason for the paucity of federal governmental regulations in industrial health lies in the broad delegation of police powers to the states by our constitution. Through the device of goods or products moving in interstate commerce, however, the potential ground for much federal control exists, although rightly little used.

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Activities of Federal Agencies in Occupational Health

Since 1914, most federal governmental activities in occupational health have been conducted by the Public Health Service through, first, the Office of Industrial Hygiene, then the Division of Industrial Hygiene, and now the Occupational Health Program. In keeping with public health tradition, activities of the Public Health Service in occupational health have been field investigations, basic laboratory research, and assistance to federal, state, and local official agencies, particularly health departments. Perhaps the single greatest contribution of the Public Health Service has been the application of epidemiological principles, thinking, and practices to the study of occupational diseases. Early in the studies of occupational diseases, Public Health Service officers, skilled in epidemiological techniques, began correlating the medical evidence of disease with environmental findings to ascertain the specific material in the work of environment causing disease. In addition, they attempted to determine the effects of varying amounts of the toxic material and similarly the effects of varying lengths of exposure to the toxic material.

Recurrently the dust diseases have been the subject of field studies and laboratory investigations including the epidemiological correlation of tuberculous infections with silicosis and epidemiological studies of silicosis and other pneumoconioses. These many studies resulted in 1935 in a publication entitled "Determination and Control of Industrial Dust," a significant and highly regarded document in the control of dust diseases.

Not all the field work and laboratory research has been confined to the dust-induced occupational diseases. Other materials—toxic metals, solvent vapors, ionizing radiation — and the industrial dermatoses have been studied and reported upon. The role of the Public Health Service has been that of leadership in the field, achieving good hygienic practices in industry through careful delineation of occupational diseases and technical methods for their control. Also, technical assistance to state agencies and industries using the broad educational approach has been a rewarding effort.

Today the industrial health research activities of the Public Health Service are headquartered in well-developed laboratories located in Cincinnati, with a smaller laboratory in Salt Lake City. The medical, engineering, and toxicological activities are united, and the epidemiological approach is jointly used in all field studies of occupational diseases. Present studies include the measurement and control of such physical agents as ionizing radiation, radiant energy, and noise. Toxicological studies on cobalt, vanadium, and ozone are nearing completion, while studies on some of the newer metals are starting. On the clinical side, studies of the dermatological problems associated with some of the new chemicals widely used in industry are in progress. Also, studies of pulmonary function and the influence of particle size and surface area of dusts upon the development of disease are being carried on. Still in progress is the long-term field and laboratory study of the health hazards of uranium mining and milling, while a new field of study now is starting to evaluate quantitatively the relationship between the development of silicosis and silica in the work environment.

The Bureau of Mines in the Department of Interior long has been interested in the health effects of dusts, fumes, vapors, and gases upon those employed in mines and the mineral industries. Traditionally the Division of Health and Safety has leaned heavily upon Public Health Service for medical talent, with health studies frequently being undertaken jointly with the Public Health Service. Much work over the years has been done on the theory and practice of mine ventilation. Of long concern has been the protection of workers against toxic gases, fumes, and dusts through developing adequate respiratory protective equipment. In addition, research studies of electrical equipment and explosives used in mines to improve mine safety are being carried on. The research program of the Bureau of Mines largely is carried out in its laboratories at Pittsburgh.

In recent years the Bureau of Mines by federal legislation has been made responsible for the safety of men employed in coal mines. It now has the authority to order a coal mine closed if it finds unsafe or hazardous conditions. With this responsibility have come renewed efforts to ascertain the effects of coal dust upon the production of pulmonary disease and increased emphasis on mine safety.

At the federal level another agency, the Department of Labor, has much interest and activities in the field of occupational health. The Labor Department was established and charged with "promoting the interests of the working man." Its Wage-Hour Division is responsible for enforcement of the Walsh-Healey Public Contracts Act governing the production of goods for the federal government. This Act specifies: ". . . no part of such contract will be performed nor will any of the materials, supplies, articles, or equipment to be manufactured or furnished under said contract be manufactured or fabricated in any plants, factories, buildings, or surroundings or under working conditions which are unsanitary or hazardous or dangerous to the health and safety of employees engaged in the performance of said contract. Compliance with the safety, sanitary, and factory inspection laws of the State in which the work or part thereof is to be performed shall be prima-facie evidence of compliance with this subsection." Under this Act, the Labor Department has regulations covering healthful working conditions with which a contractor producing goods for the federal government must comply. These regulations predominantly cover in detail the safety aspects of working conditions with less specific material on the medical aspects, although the American Conference of Governmental Industrial Hygienists' 1950 threshold limit values are specified in the 1956 Safety and Health Standards published by the Department of Labor for contractors producing under the Walsh-Healey Act. The Labor Department has inspectors who inspect the work establishments of such contractors, and those who fail to comply are not permitted to bid upon future government contracts.

In addition, the Labor Department is deeply concerned with accident prevention and assists in training personnel for state labor departments in industrial accident prevention. The Labor Department helps sponsor two federal government activities of considerable significance in occupational medicine: the annual President's Conference on Occupational Safety and the President's Committee on Employment of the Physically Handicapped.

The Bureau of Employment Security, Department of Labor, administers the Federal Workmen's Compensation Act, which covers not only federal employees but longshoremen and certain harbor and dock workers. This Act frequently is held up as a model for state legislation in this field, with changes in this Act at times presaging changes in the state statutes.

The Department of Defense is engaged in numerous activities in the field of occupational health. The Army Environmental Health Laboratory, Army Chemical Center, Edgewood, Md., is engaged in extensive toxicological studies of toxic gases, particularly the anticholinesterases or "nerve gases," in connection with its research in chemical warfare. The Navy conducts research studies on toxic materials and occupational diseases at the Naval Medical Research Institute in Bethesda, Md. The Air Force centers its research in toxic fuels, aviation and space medicine, at Wright Patterson Field, Ohio. All three services, moreover, have extensive preventive industrial hygiene-occupational medicine programs in operation for the protection of their employees in Army arsenals, Navy shipyards and Air Force bases and repair shops. In addition, the Department of Defense supports research of great significance to occupational medicine at universities and in private laboratories.

The Atomic Energy Commission at its large operational centers maintains excellent industrial hygiene-occupational medicine programs for the protection of its employees and the surrounding communities. The Atomic Energy Commission has established regulations for the protection of the health of individuals using radioactive materials and some nonradioactive materials, such as beryllium and zirconium, that are widely used at atomic energy installations. In addition, the Atomic Energy Commission supports scholarships in industrial medicine, industrial hygiene, and nuclear physics at universities offering training in these specialties. It also supports considerable laboratory toxicology and radiation research of interest to occupational medicine in numerous universities and research centers.

The Department of Agriculture engages in some activities in the field of occupational health. It has fostered research on the toxic effects of the economic poisons, the insecticides, pesticides, and herbicides. This information is used widely in the protection of personnel engaged in crop dusting, spraying, etc. Considerable of this research emanates from its research laboratories in Orlando, Fla. In addition, the Department of Agriculture has done much work upon the zoonoses, both in basic disease research and in development of control techniques, to prevent man from contracting the diseases of animals.

The Department of Commerce, Bureau of Standards, calibrates instruments and has developed new instruments. It also establishes standards of accuracy for certain instruments used in the field. In addition, it has participated in developing various health and safety codes. Those in connection with radiation protection are, perhaps, best known.

Several federal governmental independent commissions or boards have some activities relevant to occupational medicine. The Railroad Retirement Board, among other things, establishes physical standards for railroad employees and rules on physical disability for retirement. The Interstate Commerce Commission has established physical requirements for bus and truck drivers engaged in interstate commerce. The Civil Aeronautics Board formerly established physical standards for pilots, navigators, and civilian flight personnel; in addition, it specified the time and extent of the periodic physical examinations and certain aspects of working hours and conditions. These functions now are incorporated into the newly created Federal Aviation Agency. This agency has established a top-level position of civil air surgeon, long needed to bring proper medical leadership to these important functions.

Other federal agencies, among them the Food and Drug Administration, Post Office, Federal Trade Commission, and Small Business Administration, have ancillary interests and programs that impinge less directly upon industrial occupational health operations than do the activities heretofore described.

Activities of Official State Agencies in Occupational Health

Unlike the federal government, state governments have direct legal responsibility for the health and safety of employed workers. State laws, although generally adequate, are implemented by relatively few specific regulations, particularly with respect to protecting the health of employed persons. State have established, however, and do enforce minimum standards of safe working conditions.

In 1913, two states, Ohio and New York, established the first state industrial hygiene programs. In the next 20 years only two more states, Connecticut and Mississippi, initiated industrial hygiene programs. Actually in 1935, when the Social Security Act was passed, only seven states had industrial hygiene programs in operation. With the federal grant funds

available to state health departments from the Social Security Act, and under the stimulation of the Public Health Service, 23 additional states launched industrial health programs under the aegis of their respective state health departments. Later, from 1947 to 1950, $1,000,000 of federal grant-in-aid funds to state health departments annually were designated specifically for industrial health activities. Under this added impetus industrial health agencies came into being in all but two states, Delaware and Nevada.

In 1950 these 46 state agencies had a total budget of $2,500,000, about half being federal funds. Although these monies actually represented only about 1% of the total state funds budgeted for public health work, some attrition of state industrial health activities ensued with the loss of the earmarked $1,000,000 of federal funds in 1950.

Now there exist industrial health agencies in 39 states, the District of Columbia, Hawaii, and Puerto Rico. The services available from these agencies, although varying widely, frequently are limited because of the acute shortage of trained professional personnel. Medical and nursing personnel now comprise only 17% of the professional staffs, the rest being industrial hygienists. Thus it is easy to see why 90% of the activities of state industrial health agencies are confined to technical and environmental studies, with only 10% of services to industry involving medical and nursing consultations. Even with 90% of the activities centered on technical environmental investigations, only about 8% of the nation's work force each year are directly touched by such services. The small plant without medical or industrial hygiene resources is most in need of direct services from the state industrial health agencies.

The smallest state agency consists usually of a single industrial hygiene engineer working alone and without laboratory or analytical assistance. He can give only limited consultation service to small industries on environmental hazards, toxicity of chemicals, and methods of controlling these hazards. Larger units, having good analytical laboratories and sampling instruments, in addition to general consultation work, make numerous investigations of the work environments. This involves recognition of possible health hazards present, their evaluation by appropriate quantitative measurement and experienced judgment, and specification of control measures when needed. The few agencies having medical and nursing personnel are able to give industry complete services in occupational disease detection both clinical and environmental as well as consultation services not only in industrial hygiene but in occupational medicine, including the organization and operation of in-plant clinics. The state industrial hygiene agencies, designed primarily for direct service to industry and the workers, have been the subject of rather serious jurisdictional disputes and much friction between state labor and health departments over primary responsibility in this field. Actually, the problem remains unsolved, since a logical case can be made for either agency along the following lines of reasoning.

Labor departments were established to promote the best interests of the working man. They are charged with promoting his economic interests and protecting him against injury while on the job. In fact, most state labor departments are engaged in a complete worker-welfare program, a vital portion of which is the protection of the worker against injuries arising out of the work situation. Protection from physical injury—the official industrial accident prevention program—is in the state labor department; so why should not the prevention of chemical injuries also be in the labor department? Labor departments believe the total health and safety of the worker is properly within their jurisdiction. In addition, a labor department has a larger inspectional staff and specific enforcement authority, and so can better identify hazardous working conditions and enforce their early correction.

Health departments insist that they are charged with, and responsible for, protecting the total health of the people of the state. Obviously this includes all diseases, not just communicable diseases. Total community health is the business of official health departments. Therefore, it would be quite illogical to pick up one group of diseases and place responsibility for them in a nonhealth agency. Moreover, industrial hygiene and occupational health are not matters of routine factory inspection. They require scientific investigations by trained, professional personnel who perform best in the more scientifically oriented agency — the health department. The same epidemiological principles so successfully used in combating communicable diseases are used in appraising the occupational diseases. If we hope ever to bring occupational diseases under control, it will require all the medical-epidemiological skills that health departments can bring to bear, in addition to technical industrial hygiene skill. Moreover, since occupational diseases and work connected injuries account for only 8% or less of total sickness absence from work, it is most important to bring all the

forces of the health department to focus on the problem of total worker health. Therefore, occupational health-industrial hygiene should be a part of an over-all adult health maintenance program of all official health agencies.

In practice, three states have located their official industrial health agency in their respective labor departments. In New York and Massachusetts, this has worked well for many years. In Illinois, the responsibility for industrial health was transferred from the health department to the labor department about 1951. The health department largely ceased functioning in this area, and the labor department has established an industrial hygiene unit in the factory inspection division.

In a number of states there is excellent coordination between labor and health departments with no duplication of services. For example, when a labor department inspector notes a possible toxic hazard, he requests the health department to send technical personnel to examine the situation and make appropriate studies. The health department industrial hygiene personnel performing these services render a report to the labor department showing the results of the investigation and recommendations for correcting the situation, if such be required. The labor department incorporates these findings in its over-all report to the industry. Ordinarily health department-initiated studies revealing significant health hazards are reported directly to the responsible industrial management and usually the recommendations for correcting the situation are complied with voluntarily. However, when a recalcitrant employer refuses to heed these suggestions, the situation is reported to the state labor department for assistance in bringing pressure to bear, and labor departments willingly cooperate.

Better to serve the industries and workers of the state, many state health departments have district or regional offices placed strategically about the state to bring direct services to the people and industries in the surrounding area. Although in some instances these branch offices house only industrial hygiene activities, more frequently other health department activities also are present.

Activities of Local Government in Occupational Health

State health department preventive programs widely are augmented by local health departments, which supply most official health services directly to the people. State labor departments, on the other hand, have no local counterpart of local health departments. Problems arising in industrial health have been presented to the local health departments for decades. Many local health departments investigate such problems sufficiently to ascertain if a health problem exists and what kinds of expert assistance may be required for its solution. A call is then placed to the official state agency for appropriate assistance. In general, this works well if the official state agency is adequately staffed, regardless of whether it is in the health or the labor department.

In 1934, Haven Emerson, in his presidential address to the American Public Health Association, urged all official health organizations, federal, state, and local, to concern themselves with prevention of occupational diseases and, when possible, to create a special office for these activities. In certain widespread, intensely industrialized areas, local health departments have established their own industrial health services and the state has gladly given over to them the industrial health responsibility for that community. Baltimore and Detroit in 1936 were the first local health departments to establish separate bureaus of occupational disease or industrial hygiene.

At the present time, 20 local health departments have established industrial health activities in separate bureaus or units and another 10 show limited activities in this area. Although these activities function independently of the state official agency, good integration uniformly has been achieved. Because of the scarcity of trained personnel and the expense in equipping and maintaining full-scale industrial health units, only the larger city-county units are likely to engage in this activity.

The American Conference on Governmental Industrial Hygienists

In 1937, the American Conference on Governmental Industrial Hygienists was formed to provide a forum for the exchange of information and discussion of problems peculiar to those engaged in official government industrial health agencies. Full membership is reserved for individuals employed by governmental agencies—federal, state, and local. University teachers of industrial health may become associate members. The organization is devoted to the development of the administration and technical aspects of worker health protection. Of the numerous committees, two have been most productive: First, the Committee on Industrial Ventilation, which has produced an excellent, widely-used manual on

industrial ventilation, and, second, the Threshold Limits Committee, which has produced those generally accepted standards for airborne toxic materials, the threshold limits—or, as commonly called, the maximal allowable concentrations. They are, of course, based upon an eight-hour exposure, five days a week, for a healthy adult. The threshold limits set by the Conference are those subsequently usually adopted by the states in their official industrial health regulations and codes. These threshold limits are under constant revision as new facts become available. Also, as new toxic materials come into use in industry, a threshold limit is established when sufficient toxicological information becomes available.

Summary

American industry generally desires to protect the health of its employees. The motivation for this is not entirely humanitarian, for it is proved "good business."

Many federal governmental agencies are engaged in broad industrial health programs for the protection of their employees. In addition, several federal governmental departments engage in occupational disease field studies and toxicological research of importance in occupational medicine. Except in a few isolated instances, the federal government does not establish and enforce standards covering environmental working conditions. The principal role of the federal government, particularly the Public Health Service, in occupational health has been research and the dissemination of knowledge and securing good health protection for workers through education.

Occupational health agencies at the state and local levels of government are located predominantly in health departments because of the influence of the Public Health Service and the federal grant funds available to state health departments. Thirty-nine state and District of Columbia industrial health agencies, along with some 20 similar local industrial health agencies, provide most of the official governmental services to industries and industrial workers. Small plants without industrial health personnel most in need of the services from official industrial health agencies frequently do not recognize their plight. Services to workers and industries from official agencies are limited by lack of staff and facilities. Only about 8% of the nation's work force are touched by activities of the governmental agencies per year. Less than 1% of funds budgeted by state and local health departments for protecting the health of our people is expended for occupational health.

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The Epidemiology of Byssinosis

—ADVENTURE AND MISADVENTURE

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SOME 12 years ago the newly founded department of occupational health in Manchester regarded byssinosis as a small and diminishing problem. During the 6 years between 1942 and 1947 only 39 cotton workers out of some 60,000 at risk were deemed to be disabled by the disease. New methods of dust control were believed to be successful, and the few men who were disabled were thought to be the victims of the conditions which no longer existed. However, the health of cotton workers was unexpectedly brought to the fore in 1947. The *British Medical Journal* (1947) stated that the inhalation of textile dusts was a steady source of death from nephritis and a group of conditions whose common factor was hyperpiesis. This hypothesis was based on the Occupational Mortality rates of the Registrar General (1927; 1938). However, Platt (1947), the Professor of Medicine in Manchester, countered this statement by suggesting that a high incidence of hyperpiesis could be explained by hereditary factors in an inbred population.

An examination of the mortality data indicated that much of this excess of cardiovascular-renal deaths in the cotton workers was due to respiratory deaths and cor pulmonale which were wrongly allocated to the cardiovascular group of diseases (Schilling and Goodman, 1951). But when allowance was made for this, there still appeared to be an excess of cardiovascular deaths among cotton workers, particularly those most exposed to dust at their work.

It is likely that we would not have pursued this subject any further if we had been more experienced in research. The evidence that there was an industrial hazard in the cotton industry was very tenuous. Nevertheless the hypothesis that exposure to cotton dust was a factor in producing hyperpiesis was plausible and an attractive one for research. It might shed light on the etiology of cardiovascular disease in middle life. It was an opportunity to break new ground in an industry which was close at hand. The suggestion that the cardiovascular deaths of cotton workers were just as likely to be caused by heredity as by occupation was a challenge and not a brake on a new department of occupational health, seeking new fields of inquiry.

Survey of Cardiovascular-Renal Disease in Cotton Workers

It was decided to undertake a field study of cardiovascular-renal disease in cotton workers with special reference to hypertension. At that time, Bradford Hill (1951), at the London School of Hygiene and Tropical Medicine, was emphasising the importance of studying truly representative samples of populations. If many people refuse to be seen, the remainder may not be representative of the population. The higher the lapse rate, the less is the value of the research. By his standards and because of our own desire to make the field survey a more respectable method of research, high lapse rates could not be accepted as they had been in the past. Even in the classic field study of coal miners by the United States Public Health Service (Flinn and others, 1941) only 80% of the defined populations were examined. We had to learn that a low lapse rate is achieved only by hard and painstaking preparation to gain the support of employers, foremen, and trade unions. Even then it was often necessary to spend many hours persuading, but never compelling, the reluctant to come for examination. A research worker may be a

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good advocate, but it is easy to become overforceful when faced with the prospect of a laborious study being wrecked by the workers refusing to cooperate. The Pneumoconiosis Research Unit was showing that lapse rates of less than 5% could be achieved in mining communities. This was the standard we adopted.

Ten mills spinning low-grade cotton were chosen for this first field survey. Some 250 men aged 35 to 64 were examined. They were the weavers, the warehousemen, and the card and blow-room workers. The last named group of men were exposed to most dust and were found to have significantly higher blood pressures than the weavers and warehousemen (Schilling, Goodman, and O'Sullivan, 1952). The number who had hypertension, however, was small and did not suggest that hyperpiesis was a serious occupational risk. A later survey revealed no such differences in the blood pressures of men in dusty and in nondusty jobs (Schilling, Hughes, Dingwall-Fordyce, and Gilson, 1955). This was small return for a laborious investigation which had taken nearly 18 months to complete. We had learned for ourselves how misleading occupational mortality rates can be, particularly for the cardiovascular diseases.

But just like the Princes of Serendip (Morris, 1957) we made an unexpected discovery. We found that 66% of the 131 card and blow-room workers complained of tightness of the chest on Mondays, the characteristic symptom of byssinosis. Moreover, 15 of these were permanently and severely disabled. These mills were not necessarily representative of the whole industry, but, since all of them had some men affected, it was unlikely that the rest of the industry was free from the disease.

Survey of Respiratory Disease

It was obvious that a detailed and more precise survey was needed to ascertain the prevalence of byssinosis. At the same time, it might be possible to elucidate its etiology. The agent which caused the disease was unknown, and its mode of action was not understood.

Byssinosis, unlike other industrial pulmonary diseases, shows no specific x-ray changes in the lungs. It has to be diagnosed on an odd but characteristic history of chest tightness and breathlessness on Mondays, gradually extending as the disease progresses to other working days. In its later stages the clinical picture is often that recognized in Great Britain as chronic bronchitis and emphysema. It so happens that the English cotton industry is concentrated in the county of Lancashire, where chronic bronchitis is an exceptionally common disease, even among those who are not cotton workers (Goodman, Lane, and Rampling, 1953). It is hardly surprising that some doctors consider that byssinosis is chronic bronchitis, aggravated by exposure to dust in the mills, rather than an industrial pulmonary disease with a distinct etiology.

At this time, considerable attention was being given to techniques for surveying chronic respiratory disease. At the Pneumoconiosis Research Unit in Cardiff, Fletcher and his colleagues (Cochrane, Chapman, and Oldham, 1951; Fletcher, 1952) demonstrated the unreliability of the clinical history in respiratory disease. Since byssinosis could be diagnosed only on the clinical history, the validity of this would first have to be assessed.

Gilson and Hugh-Jones (1955) at the Pneumoconiosis Research Unit were also developing methods of measuring pulmonary function in field surveys. They showed that in coalminers the radiological progression of pneumoconiosis was associated with a diminished maximum breathing capacity, particularly in the more advanced stages of the disease. This suggested a second aim of the investigation, namely, that cotton workers should also be tested to see whether progression in byssinosis was associated with impaired maximum breathing capacity. The possibility of measuring lung function objectively in this disease made us decide to undertake a survey. We used a modified Gaensler apparatus to measure maximum breathing capacity (M.B.C.).

In previous studies it had been found that as byssinosis progressed the symptoms occurred on other days than Mondays. Workers were graded on their history as normal—no chest symptoms; Grade I—with chest tightness on Mondays only; Grade II—with chest tightness on Mondays and other working days. Two observers examined each man independently at intervals of about four months to see how far they agreed in their diagnoses. The inquiry was limited to mills spinning the coarser grades of cotton. The coarse spinning trade is concentrated around Oldham, a large industrial town with 112 mills. We selected the 28 which were most likely to cooperate. This was an error in epidemiological technique. We should have taken a random sample of the mills, and if all or nearly all had cooperated our results would have been representative of this section of the trade. If many of the mills had refused to cooperate, we would have been no worse off then we were with a group of selected mills.

At first we omitted the women workers from our survey and concentrated on the older

Table I—Comparison of Byssinosis Gradings in 183 Male Cotton Workers

Observer B: Byssinosis Grade	Observer A: Normal	I	II
Normal	72	6	—
I	6	47	17
II	1	14	20

Complete agreement in 139 (76%); agreement on the presence or absence of byssinosis, 139 +14 +17 = 170 (93%).

men working in the card and blow-rooms. All men aged 40 to 59 working in these rooms were included in the survey. Men of the same age from two engineering works in the same town served as controls. In the survey there were some 200 cotton workers and 100 controls, of whom more than 95% were seen.

In the men seen by both observers, 76% of the gradings of byssinosis were identical. On the actual presence or absence of byssinosis, there was a 93% agreement (Table I) (Schilling, Hughes and Dingwall-Fordyce, 1955). After consultation the observers agreed on the diagnosis in 20 more workers. In 24 men on whom the observers failed to agree, the less favorable diagnosis was chosen. Age for age, the average maximum breathing capacity (M.B.C.) of the normal cotton workers was higher than the M.B.C. of the men with Grade I byssinosis. The latter was higher than the M.B.C. of men with Grade II byssinosis (Fig. 1). Twelve of the men from the engineering works had chronic bronchitis, but none gave a history like that of byssinosis.

It became clear from the histories of the men with byssinosis that in its early stages

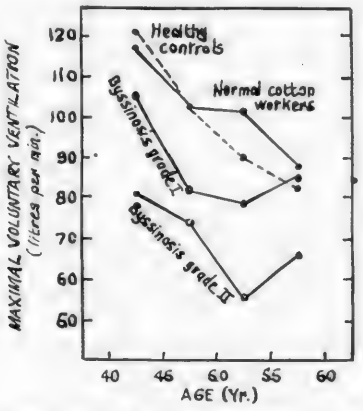

Fig. 1—Maximum breathing capacity (mean voluntary ventilation) of cotton workers and healthy controls.

Table II—Prevalence of Byssinosis in Card-Room Workers Aged 40-59 Years

	Number at Risk	Number with Byssinosis	Percentage with Byssinosis
On carding engines (men)	35	24	69
Near carding engines (women)	109	51	47
Distant from carding engines (women)	109	25	23

$\chi^2 = 27.33, n = 2, P < 0.001$

Table III—Prevalence of Byssinosis in Men Aged 40-59 Years in Different Types of Mills

Manufacturer	Number at Risk	Number with Byssinosis	Percentage with Byssinosis
Fine cotton	51	18	35
Medium cotton	75	46	61
Coarse cotton	75	52	69

$\chi^2 = 15.06, n = 2, P < 0.001$

the disease was not like chronic bronchitis. It is only in its later stages that it may be difficult to distinguish from chronic bronchitis.

Nearly two thirds (115) of the 190 cotton workers had byssinosis, and 23 (14%) were seriously disabled by it. Five per cent of the men from the engineering works were disabled by chronic bronchitis. The proportion of men with byssinosis was similar to that found in our first field survey.

Follow Through

As so many of the men were affected, the survey was extended to the women cotton workers in the same mills and to men in other mills spinning different types of cotton. These subsequent studies revealed a consistent pattern of disease.

First, the nearer the people worked to the carding engines, the higher was the prevalence of disease (Table II) (Schilling, Hughs, Dingwall-Fordyce and Gilson, 1955). Clearly, the methods of dust control were inadequate.

Secondly, in mills spinning fine cotton, the disease was much less common than in mills spinning medium and coarse cotton (Table III) (Schilling, 1956).

These results indicated two further lines of research: To determine permissible levels of dustiness by studying the relationship between prevalence of disease and air-borne dust concentrations, and to find out which fraction of the dust causes the disease and how it acts.

Mode of Action of the Dust

McKerrow, McDermott, Gilson, and Schilling (1958) studied the short-term effects of mill dust on respiratory function. In a group of card-room workers with byssinosis there was a significant fall in maximum breathing capacity during the working day but virtually no change if they were not exposed to dust. Moreover, those without symptoms of byssinosis also showed a slight fall in maximum breathing capacity during a day in the dust. On the other hand, a group of coal-miners exposed to coal dust at the coal face showed no fall in M.B.C. over the shift. From these results, it seemed that cotton dust has a specific effect on the lungs; and it is reasonable to propose that the effect is produced by a pharmacologically active constituent causing bronchial constriction. Byssinosis has been regarded as an allergic manifestation (Home office 1932, Prausnitz 1936, Werner 1955) but it is not the same as that observed in asthmatics. The effect of the cotton dust is usually gradual and not abrupt as when asthmatics are exposed to an allergen. Furthermore, a preliminary study indicated that the effect cannot be reversed by antihistamine drugs (McKerrow et al. 1958). Although the exact mode of action of the dust is still not clear, these studies have shown that diminution of maximum breathing capacity during the working day is an additional criterion for diagnosing byssinosis.

Clinical and Environmental Survey

The most accurate method of relating prevalence of disease to dust exposure is to study "prospectively" a group of workers from the time that they first enter a dusty trade. Variations in the dust concentrations to which they are exposed can then be measured and thus it would be possible to assess the total dust exposure accurately.

As byssinosis takes a long time to develop, such a study would take many years to complete. We therefore adopted a quicker though admittedly less reliable method. A group of five mills was chosen in which the layout and spinning methods had not changed substantially for 25 years. We took detailed occupational histories of the operatives in these mills and, on the assumption that the present concentrations of dust were a reasonable index of past concentrations, their total dust exposure could be calculated. The measurement of the dust presented several technical problems. We did not have a large staff of technicians, and so we had to use an instrument which was easy to operate and required little attention. Also, it had been assumed previously that byssinosis is caused by the fine dust which is deposited in the alveoli (Prausnitz, 1936; Schilling, 1956). However, the clinical and physiological effects of cotton dust indicated that the bronchi and bronchioles are affected. Thus it was necessary to measure the concentrations of the dust particles which deposit on the bronchi and bronchioles, as well as measuring the fine dust which deposits in the alveoli. We adapted the Hexhlet, described by Wright (1954), to meet these requirements. This instrument collects bulk samples of airborne dust and separates the fine particles, less than about 7μ in diameter, from the rest of the dust.

Since the cause of byssinosis was not known, the dust was analyzed to derive indices of the concentration of the three main parts of the dust, namely (1) broken cotton fibers, (2) plant debris from the pods, seeds, leaves, and twigs of the cotton plant and (3) minerals from the soil in which the cotton grows. The results of this survey will be fully reported elsewhere (Roach and Schilling). We will consider the relationship between the prevalence of byssinosis and the concentrations of fine and coarse dust. One of the outcomes of this work will be an indication of permissible levels of dustiness from dose response curves. We also hope to test the importance of the *fine* dust in another way. Volunteers will be exposed first to all the dust and then to dust from which particles larger than 7μ in diameter have been removed. The effects of these exposures will be assessed by recording clinical symptoms and by measuring changes in maximum breathing capacities. It is difficult and costly to remove the fine dust particles from the atmosphere. If these are found to be relatively innocuous, it will be of considerable practical importance.

Laboratory Research

The field work has suggested that cotton dust contains an active substance and has indicated a problem for laboratory research. This is being pursued by Miss Ann Davenport under the direction of Dr. W. D. M. Paton, Professor of Pharmacology at the Royal College of Surgeons of England.

If extracts of cotton dust can be obtained which contract smooth muscle in animal tissues and in human bronchi, a biological test will be available for identifying the causal agent. The extracts will be tested first for the presence of known contractors of smooth muscle such as histamine, 5-hydroxytryptamine, and acetylcholine.

It is also conceivable that bronchoconstriction is caused by the pyrogens which give rise to "mill fever" in cotton workers. Caminita

and others (1943) in the U.S.A. concluded that the endotoxin of Aerobacter cloacae is the pyrogen in cotton dust and suggested that repeated exposures to it might be an etiological factor in byssinosis.

Laboratory research may provide new opportunities for prevention by discovering the parts of the cotton plant which contain the causal agent. It would be much better to remove them before the cotton is baled than to extract them from the atmosphere of the mills. Also, it may be possible to develop an antidote.

Byssinosis in Other Industries

Byssinosis is not confined to the cotton mills of Lancashire. There have been many accounts of its occurrence among cotton workers in Europe (Schilling, 1956) and one from India (Shivapuri and Varma, 1957). Isolated cases have been described in the United States of America (Bolen, 1943; Emerson, 1950), but it appears to be a more serious problem in Lancashire than anywhere else. I do not believe this is because it has been investigated more energetically in England than in any other country. Where epidemiological studies have been made, as in Holland by Muller and Op de Coul (personal communication) and in Belgium by Tuypens (personal communication), the prevalence of byssinosis seems to be much lower than in England. A more acceptable explanation is that there is less exposure to dust in the mills abroad. Their cotton may contain less dust. Their methods of production may be less dusty, or their dust control may be more efficient. Climate is another factor to be considered. The cold, wet climate of the British Isles is thought to be one cause of their high death rates from bronchitis. Hammond (1958), discussing the causes for the higher death rates from lung cancer in the British Isles than in the United States of America, postulates that bronchitis may increase susceptibility to carcinogens such as cigarette smoke or air pollutants. It may be that the causal agents of bronchitis, whatever these may be, also increase susceptibility to byssinosis. This complex question can be answered only by comparable clinical and environmental studies of cotton workers in different countries. Such studies might help to illuminate the etiology of chronic bronchitis, which is a more widespread and more serious disease than byssinosis.

Discussion

There are two obvious reasons why byssinosis was not recognized as a serious problem in Lancashire. First, many of the cotton workers seen in hospital clinics in their own districts were isolated cases. Since the clinical picture presented was superficially the same as that seen in many patients with bronchitis, the significance of their occupational disease was not realized. However, when an occupational medicine clinic became fully established at a large hospital in Lancashire, 42 cotton workers with byssinosis were seen in three years and the occupational hazard became abundantly clear (Lane, 1957). Secondly, the compensation statistics for byssinosis have, until recently, grossly underrated the size of the problem. In 1946 and 1947, when the scheme was restricted to totally disabled men, only nine cotton workers were awarded pensions. In 1956 and 1957, when the scheme was expanded to include partially as well as totally disabled men and women, 408 cotton workers were awarded pensions for byssinosis.

The work reported here illustrates several uses of epidemiology (Morris, 1957). By leaving the hospital and going into the cotton mills, a problem within the community was discovered for which provisions were inadequate and inequitable. The clinical picture of byssinosis was completed by relating the earlier stages to the fully developed disease which was distinguished from the more generally prevalent chronic bronchitis. Occupations in cotton mills with high and low rates were identified. By further studies of these differences in rates in relation to differences in dust exposure, causes of the disease may be indicated and permissible levels of dustiness defined.

A general hospital which serves a defined area can provide valuable clues for this type of epidemiological research if it has a physician with a special interest in occupational or preventive medicine. But such research need not be the prerogative of universities and government departments. It is available to the plant physician and industrial hygienist, who have unique opportunities for the appraisal of suspected hazards and for studying populations and their environment.

Summary

Occupational mortality rates revealed high cardiovascular-renal death rates for cotton workers in Lancashire.

A field survey of 250 middle-aged cotton workers exposed to dust showed that cardiovascular-renal disease was not a serious risk but 66% had symptoms of byssinosis. This was surprising because only a few cotton workers were getting pensions for byssinosis.

In another survey of respiratory disease, a similar prevalence was found and 14% of the middle-aged men were disabled. The nearer

operatives were to the carding engines, the higher was the prevalence of byssinosis.

Workers exposed to cotton dust showed a fall in maximum breathing capacity during the day suggesting that cotton dust contains a pharmacologically active substance causing bronchoconstriction. Further surveys are being made to relate the prevalence of disease to air-borne dust concentrations in order to establish permissible levels of dustiness and further to define the fraction of the dust which contains the causal agent.

Laboratory research is being pursued to identify the causal agent.

Acknowledgments

The surveys described were planned and executed by members of the Department of Occupational Health at Manchester University, the Medical Research Council's Pneumoconiosis Research Unit, and latterly the Rockefeller Unit of Occupational Health at the London School of Hygiene and Tropical Medicine. I am grateful to Dr. J. N. Morris, Mr. S. A. Roach, and Dr. C. H. Wood for many suggestions in preparing this paper and to Miss Jane Cooper for help in preparing the tables.

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Occupational Skin Problems

I. MECHANISMS OF DERMATOLOGIC RESPONSE

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This is the first of a series of 12 chapters treating various aspects of occupational dermatoses. The remaining installments will appear in successive issues.

IT IS somewhat obvious that the skin, with its large surface area in direct contact with the environment, is the most vulnerable of organ systems. This is logically reflected in the fact that among all occupational diseases the incidence of skin problems is the greatest.

In order to understand and appreciate the nature of the occupational dermatoses, it is necessary to have some knowledge of the structure and function of the normal skin, the inherent defenses provided by the organ system itself, and the specific cytologic, physiologic, and biochemical alterations provoked by external stimuli. In this introductory paper, we shall review briefly the anatomical, physiological, and biochemical factors which provide the skin with several lines of defense against penetration by chemical agents, damage by physical stimuli, and invasion by micro-organisms. Of primary importance in this connection is a knowledge of the principles of percutaneous absorption and the portals of entry through both intact and damaged skin. Finally, we shall attempt to delineate the several pathological reaction patterns of which the skin is capable and describe, where possible, present knowledge of the specific mechanisms which are responsible for the particular cutaneous response.

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CUTANEOUS DEFENSES

Anatomical, Physiological, and Biochemical Factors

1. *The Epidermis*—The most superficial layers of the skin are nonviable layers upon which sebaceous and epidermal lipids, cellular detritus, and eccrine sweat are expelled. They consist of (1) the completely keratinized surface layer, the stratum corneum which is simply made up of loosely arranged horny lamellae grouped as overlapping shingles, and (2) the relatively dense barrier layer (stratum lucidum or conjunctum), through which few things normally appear to pass, and the granular layer. The barrier and granular layers constitute the so-called transitional zone which is interposed between the completely keratinized and the living cells of the epidermis. These nonviable surface layers are evolved continuously by the dynamic, constantly reproducing cells of the stratum germinativum. The destiny of these cells is to produce keratin, move surfaceward and die, but the process of doing so constitutes one of the major defenses of the skin

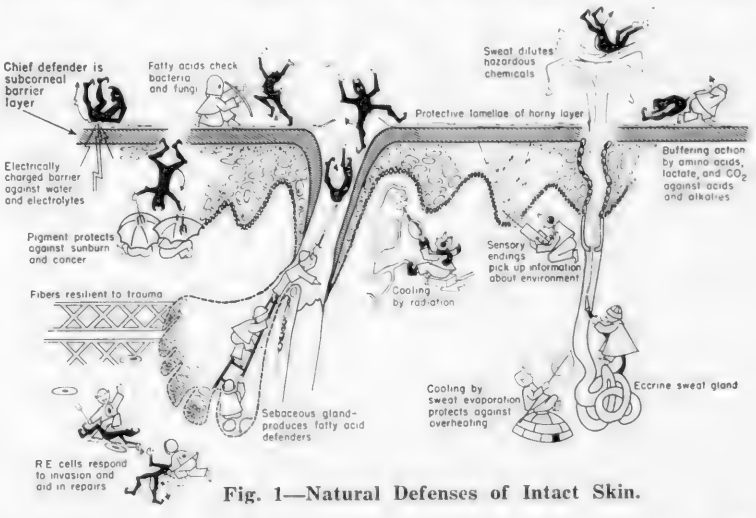
Chief defender is subcorneal barrier layer
Fatty acids check bacteria and fungi
Sweat dilutes hazardous chemicals
Protective lamellae of horny layer
Buffering action by amino acids, lactate, and CO_2 against acids and alkalies
Electrically charged barrier against water and electrolytes
Pigment protects against sunburn and cancer
Sensory endings pick up information about environment
Fibers resilient to trauma
Cooling by radiation
Eccrine sweat gland
Cooling by sweat evaporation protects against overheating
Sebaceous gland-produces fatty acid defenders
RE cells respond to invasion and aid in repairs

Fig. 1—Natural Defenses of Intact Skin.

against the external environment. The dense zone of dead cells immediately adjacent to the granular layer is the physicochemical barrier which acts to (1) prevent water loss from the skin and (2) keep out a wide variety of chemical substances, including water-soluble, ionized, nonionized materials, as well as microorganisms.[1-3] The barrier carries an over-all electronegative charge[4] and it has specific chemical characteristics which have been recently delineated.[2, 3] Gases pass through this barrier depending on the difference in vapor pressure of the specific gas on either side of the barrier.[4, 5] The thickening of the keratin layer, as well as melanin pigment, plays a significant role in protecting the skin against ultra-violet radiation. The normal protective properties of the barrier are diminished or lost completely when the skin is traumatized by abrasion, maceration, by other physical factors, as well as by chemical agents and reactions to infection. Its protective properties are lost in many skin diseases.

2. *Pigment*—The pigment of the skin is synthesized in the melanin-producing cells of the epidermis, the melanocytes, from which it is conveyed in granular form to adjacent cells of basal layer, the prickle cells, and is finally desquamated with the horny shingles at the surface. Normal skin pigment serves as a protection against damage by actinic radiation. Under suitable stimulus of such radiation, the rate of pigment formation increases and already existing pigment darkens. This response to ultraviolet rays, as well as corneal thickening, provides for added protection against further actinic radiation injury. Within recent years new and revealing information has been developed about the complex biochemical synthesis of melanin. It has provided for a much better understanding of pigment disturbances in the skin and especially those provoked by occupational exposures. The starting point of the synthesis of melanin is the amino acid tyrosine, which, in the presence of the copper-protein complex tyrosinase and oxygen, is transformed into dihydroxyphenylalanine, or dopa.[6] This initial product, in turn, acts as an additional catalyst to increase the rate of transformation of the precursor tyrosine, into dopa. From dopa to the final product melanin there are a series of intermediate steps in which such substances as dopaquinone, dopachrome, 5,6-dihydroxyindole, and indole-5,6-quinone are sequentially evolved before polymerization to melanin occurs. A variety of physiologic factors regulate the formation of melanin and particular environmental stimuli will alter pigmentation in the skin.[6] Some of the most dramatic pigment changes are produced as a consequence of occupational exposures. The mechanism of some of these changes will be discussed later on in this thesis.

3. *The Dermis*—The corium, or dermis, which lies beneath the epidermal cover is made chiefly of connective tissue cells and fibers and a matrix of ground substance all of which have important functions. The tough fibrous components provide a resilient barrier against trauma as well as a supporting structure for the blood vessels, nerves and the skin appendages; the cellular elements of mesenchymal origin play an important role both in the development and maintenance of the fibrous structure as well as providing a second line of defense against injury by physical stimuli, chemical agents and infecting micro-organisms. The cells are involved in wound healing and repair after the damage is done. The role of the ground substance may be greater than we presently believe. It does act as a means of transferring nutrients and metabolites to and from the structures within its surroundings.

4. *Sweat Glands and Blood Vessels*—The glands in the human skin consist of eccrine sweat, apocrine, and sebaceous glands. The chief function of the eccrine sweat gland is in thermal regulation which is accomplished by the surface evaporation of water at critical temperatures. The vascular bed of the skin, by virtue of continuous alteration in rate of blood flow, also plays a role in thermal regulation at environmental temperatures of 25° to 31° C (zone of vascular control). Both of these are important homeostatic mechanisms.

5. *Sensory Perception in the Skin*—The sensory nerves in the skin provide the individual with information about the state of the external environment via the endings which subserve the various sensory modalities. We appreciate temperature, touch, pressure, and pain. It is one of the most important mechanisms by which the individual constantly and involuntarily detects noxious elements in the environment.

Percutaneous Absorption and Surface Biology

The pilosebaceous unit affords an important cellular surface through which substances may be absorbed from without.[4, 5] Current evidence indicates that liquids and solids which are absorbed through intact skin pass transfollicularly. The relatively dense epidermal barrier which appears to prevent aqueous and nonaqueous materials from penetrating the skin does not extend below the opening of the seba-

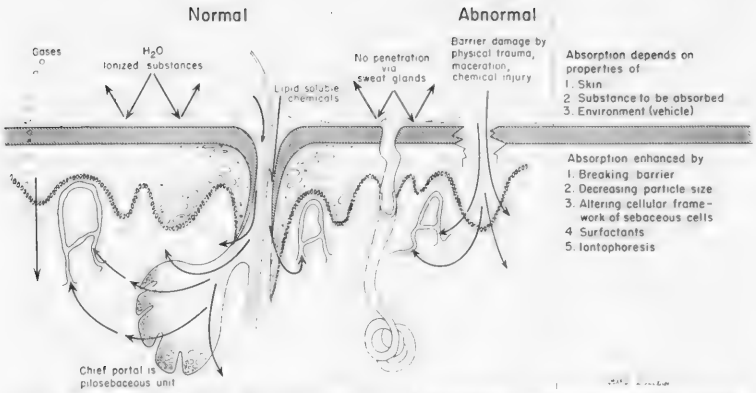

Fig. 2—Major Routes of Percutaneous Absorption: Normal: lipid-soluble substances are absorbed transfollicularly; gases penetrate transepidermally. Absorption enhanced by decrease in particle size; vehicle (ointment base) affording closer contact with pilosebaceous cells; physical or chemical damage to barrier; altering of lipoidal framework of pilosebaceous cells; surfactants; iontophoresis.

ceous duct. In the intact skin the most vulnerable surface is the cellular wall of the follicle below the sebaceous duct and the sebaceous gland. Water and ionized substances will not penetrate this cellular membrane except by electrophoresis. Most lipid-soluble and nonionizable substances, on the other hand, are absorbed transfollicularly. There is no evidence to demonstrate that the absorption of any significance occurs via the sweat ducts or glands. There is increasing experimental evidence now which demonstrates that for some substances the route may be both transepidermal and transfollicular.[7-9]

The absorption of toxic materials is influenced favorably by a variety of conditions: (1) by damage to the epidermal barrier, (2) by decreasing particle size of toxic agent, (3) by altering the lipoidal framework of the vulnerable cells with organic solvents, and (4) by the presence of some surface-active agents. With regard to the first, even some protective devices, such as rubber or plastic gloves, may increase the rate of percutaneous absorption of a toxic agent many times if the material accidentally finds its way beneath the protective cover. Gases will penetrate the skin transepidermally as described previously. The lipid layer which normally is found on the surface of the skin is a relatively poor deterrent for water or aqueous irritants. By virtue of its buffering action, the skin offers some protection against damage by both acids and alkalis. Its buffering capacity appears to depend upon such constituents as amphoteric amino acids, lactic acid, and lactate which are deposited in the horny layer by sweat secretion, and epidermal debris. There is evidence to show that the diffusion of CO_2 from within the skin to the surface also plays a role in the neutralization process.

Sweat may act as a diluent and decrease the effect of a noxious chemical agent. It may, on the other hand, promote maceration of the keratin barrier and afford greater absorption in some circumstances. The fatty acids derived from sebum which are found in surface lipids are antimicrobial. The odd numbered—C_5, C_7, C_9, C_{11}, and C_{13}—saturated free acids are more potent fungistatic agents than their even numbered neighbors.[10] The long-chain unsaturated acids are bacteriostatic for a limited group of bacterial organisms.[11, 12] To some degree, therefore, the skin has a self-disinfecting mechanism.

Genetic Factors

The inherent defense of the skin against external hazards appears to be influenced somewhat by heredity and race. The skin of persons with very active sebum secretion appears to tolerate exposure to organic solvents better than the skin of persons with less active glands.

Some persons appear to develop prickly heat or miliaria more readily than others. In such instances poral closure and sweat retention depend on individual susceptibility.[13] The integument of persons possessing considerable pigment such as Negroes, is much less likely to be damaged by ultraviolet radiation because of that pigment. In such persons sunburn is infrequent and the incidence of epitheliomas very low.[14] There may be something genetically different about the skin of a person who develops an allergic eruption of the immediate or even the delayed type from that of the person who fails to react to an identical exposure.[15]

CULTURAL DEFENSES

Of much greater importance than the natural defenses of the skin in any potentially hazardous environments are the cultural or man-made defenses. These consist essentially of two things: (1) the personal hygiene habits as well as the working habits of the individual and (2) the planned control of environmental hazards by safety engineering methods and preventive technics provided for working personnel.

CONSEQUENCES OF CUTANEOUS ABSORPTION OF TOXIC MATERIALS

The vast protective envelope, the skin, which is constantly exposed to potential injury from physical, chemical, and biological sources, in most circumstances withstands the onslaught without any abnormal effect to the skin itself or to other organ systems. However, when the inherent cutaneous defenses are unable to cope with a particular chemical exposure, the consequences may include one of several possibilities: (1) percutaneous absorption and systemic intoxication without apparent skin damage, (2) percutaneous absorption and systemic intoxication as well as cutaneous damage, and (3) cutaneous damage without systemic intoxication.

A good example of the first situation is an unprotected exposure to tetraethyl lead, which will be absorbed rapidly through the skin, and cause acute lead poisoning without apparent damage to the skin. Examples of substances which, when absorbed, may result both in cutaneous damage and in systemic intoxication, are phenol and chlorinated hydrocarbon solvents.

The varieties of substances exposure to which may result in cutaneous damage, with or without systemic involvement, are considerable and include all of the known chemical irritants and sensitizers.

CAUSES OF OCCUPATIONAL SKIN DISEASE

In any working environment the causes of cutaneous insult or damage may be physical, chemical, or biological.

1. *Physical*—Among the physical causes are friction, pressure, electricity, heat, cold, and radiation (ultraviolet, infrared, alpha, beta, and gamma rays, and roentgen radiation).

2. *Chemical*—The chemical factors in the environment afford the greatest source of injury by primary irritation, by necrotizing action, or by allergic sensitization. The chemical incitant may cause an acute or a chronic inflammatory reaction. The chemical agent may act specifically on the epidermal cells, as do keratogenic or carcinogenic agents; on pigment formation, or on the pilosebaceous apparatus.

3. *Biological*—Among the biologic incitants of cutaneous disease are the botanical, or plant, irritants or sensitizers; bacteria and fungi; the protozoa, and the arthropods—infections or infestations with which may be incurred in working environments.

PATHOLOGIC PATTERNS AND REACTION SITES

Since the skin is a complex organ system and histologically heterogenous, a particular occupational incitant may predominantly affect a single tissue component of the skin (e.g., the epidermis), or several components (e.g., epidermis, dermis, hair follicle, or sebaceous glands). The type of pathologic response may vary with the specific stimulus; e.g., irritating chemicals provoke an inflammatory response which involves the epidermis, dermis, blood vessels, and reticuloendothelial cells; repeated friction and trauma may provoke epidermal proliferation and a marked thickening of the horny layers.

Let us list the pathologic patterns as well as the structures which may be involved in specific occupational dermatoses.

1. *Inflammatory*
   - a. Primary irritation } contact reactions
   - b. Allergic sensitization } contact reactions
   - c. Photosensitization
   - d. Infections due to bacteria, viruses, fungi
   - e. Reactions to heat, cold, friction, radiant energy
   - f. Granulomatous reactions
   - g. Ulcerations provoked by deep local damage
2. *Epidermis*
   - a. Hyperplasia of epidermal cells produced by trauma, filterable viruses (warts)
   - b. Increase in keratinization, e.g., calluses, lichenification
   - c. Neoplastic changes in epidermis, e.g., keratoses, epitheliomas
3. *Pilosebaceous Unit*
   - Acne
   - Folliculitis
   - Hair damage and loss
4. *Pigment*
   - Hyperpigmentation
   - Hypopigmentation
5. *Sweat Glands*
   - Miliaria or sweat duct closure
   - Hydrocystomata
   - Anhidrosis
   - Hyperhidrosis
6. *Collagen and Elastic Tissue*
   - Degenerative changes, as with ultraviolet rays and ionizing radiation
7. *Blood Vessels*
   - a. Involved in inflammatory changes
   - b. Degenerative reactions
   - c. Proliferative reactions
   - d. Reactions to sensitizers
   - e. Reactions to low temperature and ionizing radiation
8. *Nerves*

The major role played by the sensory nerves in pathological reactions is in the perception of pain, burning, and itching. It is the latter which is symptomatic of the contact dermatoses.

1. *Inflammatory Reactions*—Contact dermatitis may be of primary irritant origin or may involve the delayed type of allergic hypersensitivity. In either case the reactive tissues are

chiefly the epidermis, and the blood vessels and reticuloendothelial cells of the dermis. If the reaction is severe and prolonged, the appendages may be affected as well. Symptoms range in severity from mild itching to a severe eczematous dermatitis characterized by blistering, redness, itching, and in some instances, pain. The primary irritant reaction involves direct damage of the tissues by simple chemical substances, such as acids, alkalis, corrosive salts, and solvents.

In allergic contact dermatitis the chemical sensitizer presumably conjugates with skin protein to form the allergen. This new substance, the antigen, is capable of altering enzyme systems involved in the production of cellular protein.[15] The altered cellular protein, which is part of, or becomes fixed in, the reticuloendothelial cell, constitutes the cell-fixed antibodies of hypersensitive persons. The reticuloendothelial cells which bear such antibodies make up the shock tissue, and when a hypersensitive person comes into contact with the original sensitizing chemical substance, the antigen-antibody reaction that occurs in the skin results in the characteristic symptoms.[15]

In cutaneous allergic reactions of the immediate type, such as urticaria, the engendering agent may be the original protein to which the individual was exposed, a metabolic product of it, or a conjugated protein derivative of a simple chemical compound. In any case the final engendering agent is capable of altering enzyme systems upon which serum globulin synthesis depends. The altered globulin or antibody which may be detected in the serum of a sensitized person will combine with the original antigen when the sensitized person is reexposed, resulting in the rapid appearance of the characteristic urticarial phenomenon.[15] This type of reaction may involve other organ systems simultaneously, and the skin response may be accompanied by asthma, rhinitis, conjunctivitis, arthralgia, headache, and gastrointestinal symptoms.

Inflammatory reactions may be produced by actinic or ultraviolet radiation, by heat, or by low temperature. Certain chemical substances enhance cutaneous reactions to sunlight by their photodynamic action. There are many such enhancing agents: essential oils, eosin, acriflavine, petroleum products, coal tar.

2. *Epidermal Effects* — The epidermis responds quickly to injury and has a remarkable restorative capacity. Repeated and prolonged trauma stimulates mitosis and results in hyperplasia.

Repeated friction and trauma to a local cutaneous site causes thickening of the epidermis and an amassing of keratin. Callus and lichenification is the organ's own protective device for avoiding damage to the more vital parts of the skin.

Repeated exposure to ultraviolet radiation and critical exposures to ionizing radiation and specific cyclic hydrocarbons will cause epidermal cells to lose their normal characteristics and become neoplastic. The biochemical and physiologic changes which occur in neoplastic cells have been the subjects of recent extensive researches by cancer investigators. Knowledge of these matters is still very limited.

3. *Pilosebaceous Reactions* — Chemical substances of related structure appear to single out the pilosebaceous unit and alter sebaceous structure and function specifically. Occupational acne is a rather common skin disease which may result from exposure to petroleum cutting oils, coal tar fractions, and chlorinated hydrocarbons, such as chlorinated naphthalenes, diphenyls, diphenyloxides, benzols, and phenols. The chemical stimulus provokes the proliferation of follicular epithelium in the sebaceous duct and follicle opening (infundibulum).[16, 17] These cells become keratinized, and plugging of the orifice results. This prevents extrusion of sebum, and that which is formed is retained. The lipid-bearing cells are then replaced by keratinizing cells, and the entire process eventually results in a sac filled with keratin lamellae and retained sebaceous lipid. This is the sequence of events which occur in the evolution of the comedo or milia and are identical with the cutaneous events which occur in acne vulgaris.[16] The chemical stimulus invokes perifollicular inflammatory response which may become severe and result in breakdown of tissue with abscess formation. The process is frequently complicated by secondary infection, which may be distressing.

Unhygienic exposures to cutting oils frequently result in folliculitis. This may be simply the result of follicular or perifollicular irritation by the hazardous material, with a secondary inflammatory reaction, complicated by acne, and frequently accompanied by bacterial infection.

Of some interest are the chemicals employed in industry that have a specific toxic effect on follicular epithelium and cause hair loss. The most potent alopeciogenic substances are thallium and the dimers of chloroprene found in neoprene manufacturing. The chloroprene dimers, which are structurally related to vitamin A, appear to interfere with the metabolism of the hair-forming cells (matrix) in the bulb

and prevent normal keratinization. The hair loss is completely reversible in this instance.

4. *Pigmentary Disturbances*—Occupational environments may alter pigment formation in several ways. The inciting factor may lead to either local hyperpigmentation or to a reduction of pigmentation. In most instances the pathologic process can be explained on the basis of interference with the biochemical synthesis of melanin and disturbance of one or more of the physiologic factors regulating melanin formation. For example, ultraviolet rays may increase pigmentation in at least five different ways[6]:

(a) Ultraviolet energy catalyzes the oxidation of tyrosine to dopa
(b) The concentration of sulfhydryl groups in human epidermis is decreased after irradiation with U.V.L. Sulfhydryl is a physiologic inhibitor of melanin formation, and when it is removed increased pigmentation occurs.
(c) The redox potential of human skin decreases appreciably after irradiation.
(d) Skin temperature is frequently increased with exposure to actinic radiation, and melanin formation is accelerated.
(e) Ultraviolet energy causes darkening of melanin already present in the skin.

Chemical materials which enchance the action of U.V.L. on the skin, such as coal tar products, low-boiling petroleum products, essential oils, and certain dyes, both increase the degree of inflammatory reaction to the erythematogenic wave lengths and cause hyperpigmentation at the exposed site.

Decrease in pigmentation or pigment loss (leukoderma) may be acquired in industrial exposures to agerite alba, a rubber antioxidant which is the monobenzylether of hydroquinone. The explanation of its effect lies in the fact that the latter substance is chemically very similar to the quinone intermediates evolved in melanin synthesis, and it probably competes for the enzyme tyrosinase with such compounds as dopaquinone. The agerite alba may veritably remove the tyrosinase from the reaction and cause a halt in new melanin formation.

5. *The Eccrine Sweat Glands and Ducts*—A cutaneous problem of considerable importance which is provoked by working environments in which the environmental temperature is high is prickly heat, or miliaria rubra. The pathogenesis of this disease has been ascertained and lesions reproduced in experimental subjects.[13] The orifice and upper portion of the sweat duct may, in hot humid atmospheres, become occluded by keratin maceration and nonspecific irritation. This occurs especially in environments in which chemical agents may cause some damage to the duct orifice. Epidermal injury produces abnormal keratinization and hyperkeratotic plugging of the duct orifices. When the glands are subsequently stimulated thermally, sweat secretion is trapped in the plugged ducts. As pressure increases the sweat breaks through the duct wall and extravasates into the skin, resulting in vesicle formation and frequently an inflammatory response in which the discomfort from pruritus is severe. In World War II, among American troops in the South Pacific Theatre, prickly heat was one of the major causes of inactivation of combat personnel.

6. *Collagen and Elastic Tissue Damage*—Collagen and elastic tissue degeneration and fragmentation are among the cutaneous effects of prolonged exposure to sunlight. Persons who work out-of-doors, such as farmers, ranchers, road construction workers and sailors, are more likely to exhibit these tissue changes. Among the chronic effects of overexposure to ionizing radiation (radiodermatitis), sclerotic, degenerating collagen fibers are generally observed.

7. *Blood Vessel Changes*—The blood vessels of the skin are notably reactive to irritants and sensitizers. They are singularly damaged in prolonged low temperature exposures as in pernio, immersion foot, and frostbite. The blood vessels constitute an area of fundamental pathologic change resulting from prolonged and excessive exposure to ionizing radiation. The vessel walls become fibrotic with varying degrees of occlusion leading to ischemic changes, including atrophy, necrosis and ulceration. Chronic radiation effects are also manifested by irreversible dilatation of the capillaries and telangiectasia.

8. *Sensory Perception Problems*—While cutaneous sensation is informative as well as protective, potential and actual damage will be reflected in cutaneous feeling. Pain, for example, is experienced with injury by specific mechanical trauma, radiation, heat, cold, electrical energy, and chemical irritants. It is experienced with a severe inflammatory response to infection. Itching is apparently a variant of pain, subserved by the same receptors and nerve fibers and elicited by stimuli which are quantitatively lower than the threshold level for pain. It is an ever-present symptom of many skin diseases, including those of occupational origin. The superficial inflammatory reactions

provoked by primary irritants and allergic sensitizers are characterized by pruritus as well as the objective signs of inflammation.

We have attempted to present in this introductory paper, a review of the several factors and mechanisms which may be involved in the dermatologic response to occupational or environmental stimuli. The skin is unique in that its inherent defenses are both numerous and effective and it has great versatility insofar as modes of reaction to occupational environments are concerned.

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The Toxicology of the Boranes

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THE FIRST cases of boron hydride poisoning were reported in 1951 by Rozendaal,[1] and since that time great effort has been made to elucidate the toxicology of the boranes. At the time of the first report, there were only seven known boron hydrides, and, of these, only diborane could be made in any quantity. Since then, our knowledge of the chemistry of these compounds has greatly increased, our ability to produce other boranes has been limited only by practicality, and our clinical experience gained from working with them has been greatly enlarged. The extreme toxicity of these compounds has hampered the progress in the development of their toxicology and pharmacology because of the difficulties in measuring the small quantities that are present in biological materials or the environment sufficient to produce severe poisoning.

Chemistry

Compounds of boron hydrides are in many ways analogous to the methane series, and in general have the form of $B_nH_n + 4$ or $B_nH_n + 6$. The $B_nH_n + 4$ is the stable group, and these are the compounds which are currently of interest. The high energy content of these compounds has led to their incorporation in the government's high energy fuel program. These compounds are very reactive and very strong reducing agents, reacting readily with organic amines, unsaturated hydrocarbons, various heterocyclic amines, alcohols, ketones, and halogenated hydrocarbons. Diborane is the only boron hydride that is a gas under normal temperature and pressure. The boranes are rather soluble in hydrocarbons but are only slightly soluble in water. Diborane hydrolyzes rapidly in water to form boric acid and hydrogen, whereas pentaborane hydrolyzes slowly and decaborane very slowly. The amine boranes are very stable and hydrolyze very slowly.

Industrially, in addition to their use as fuels, the boranes are important as selective reducing agents, fuel additives, initiators of rubber vulcanization in lieu of sulfur, bactericides and fungicides, and as initiators of ethylene, vinyl, styrene, and acrylic polymerization.

The reactive properties of these compounds, their reducing properties, plus their ability to react with nitrogenous materials, certainly suggest that they would have toxicological properties.

General Toxicity of the Boranes

Extensive animal experimentation on some of the boranes as well as limited observations of their effects upon humans have been published. The relative toxicities of these compounds can be judged by comparing the acute toxicities for experimental animals. This information is summarized in the table.

Diborane (B_2H_6)

Since diborane is a gas under ordinary conditions, the hazard is respiratory. Diborane hydrolyzes rapidly, and so most if not all probably is converted to boric acid in the lung, and local damage may be expected from the reaction that takes place on the respiratory surface. The relatively small amount of boric acid produced and absorbed will be handled at nontoxic levels by the body and excreted in the urine. To explain the systemic effects of diborane, it must be remembered that when diborane is in contact with air a small quantity is converted to higher hydrides; and, in addition, it is conceivable that some nonhydrolyzed diborane may be absorbed.

Rats and dogs dying of acute exposure to diborane showed evidence of respiratory distress.[5, 6] Kunkel[7] found that there was a fall in blood pressure, a decrease in intestinal peristalsis, and a decrease in cerebral cortical activity. As the animal approached the terminal stage, it developed a bradycardia that progressed to ventricular fibrillation. Pathologically the lungs showed edema and hemorrhage. One dog exposed to 320 ppm for 15 minutes died four minutes later.[4] At 50 ppm for 15 minutes, several dogs became dyspneic and developed bradycardia and a fall in blood pressure. Dogs and rats died when exposed to 5 ppm to diborane six hours a day, five days a week, but at 1 to 2 ppm there was no death attributed to diborane.

Lowe and Freeman[8] compiled the records of 39 cases of diborane exposure and described 1 hospitalized case. Rozendaal[1] described one case of pneumonia thought to be due to diborane. The symptoms of these cases, in order of frequency, were chest tightness, cough, headache, nausea, chills, dizziness, and drowsiness. The cases of Lowe and Freeman were taken from dispensary records and so included only those cases serious enough to require medical care and those in which apprehensiveness prompted the men to seek medical care. Physical examinations of these men revealed no abnormal chest finding, but the pulse was usually elevated and pulse pressure was widened.

If all the men who work with diborane are questioned, most of them tell of similar complaints occurring many times, but they continue working or simply stop to get a few breaths of fresh air. Their usual complaints are cough, tightness in the chest, and perhaps headache. All say that only a few "whiffs" of this gas need be inhaled to produce these symptoms. The symptoms come on in a few minutes and last up to an hour. The worker is then completely free of symptoms and he can continue to work without difficulty. Occasionally the same symptoms recur at home, together with chills and fever, but the worker returns to work in the morning asymptomatic.

This apparent high frequency of exposures to diborane points up the hazardous qualities of this gas, but it is important to note that most of the exposures cause only minor distress. There are several factors that can be pointed out to explain this statement. Diborane has a distinct odor ("sickening sweet" or "rotten eggs") that is quickly recognized, and, in addition, because of the prompt onset of symptoms after inhalation, the workers quickly leave the area and so the exposure is usually brief. The short duration of the symptoms can be related to the minimal exposure and also to the rapid hydrolysis of diborane. Nevertheless, the possibility does exist that a man could develop a severe pneumonitis if for some reason he could not leave a contaminated area.

Though no case of chronic bronchitis or pneumonia has been reported, this possibility should always be considered. Sufficient exposure could occur on a subacute or chronic basis. In addition, it has been stated that an allergic response may be produced by boron compounds,[9] but no case of asthma has been seen.

When a patient can relate the onset of symptoms to definite exposure, then symptoms follow the exposure so closely that there is little doubt that the man is suffering from the toxic effects of diborane. It should be pointed out, however, that merely detecting the odor of diborane does not mean that symptoms will follow. In addition, since the symptoms of diborane poisoning are respiratory and nonspecific, often the diagnosis must be only presumptive. If chills and fever occur, it becomes even more difficult to differentiate diborane poisoning from an upper respiratory infection. The diagnosis becomes clear only when the brief duration of symptoms makes the relationship to diborane acceptable. To complicate the picture further, it is apparent that an upper respiratory infection would make the worker more susceptible to a lung irritant such as diborane, and so the patient may well have both.

There is no laboratory test that can be used to establish the diagnosis. The diborane is converted rapidly to boric acid, and so blood and urine cannot be analyzed for diborane, and up to the present time, analysis for boron has been so laborious that it has not been done either. In addition, atmospheric monitoring is needed to determine just how much exposure has occurred but no monitoring device is available to do this.

Higher Hydrides

Pentaborane and decaborane are grouped together because there is much to suggest that they act similarly pharmacologically. Pentaborane (B_5H_9) is a liquid with a vapor pressure of 185 mm Hg at 25 C. Decaborane ($B_{10}H_{14}$) is a white solid with a vapor pressure of 0.05 mm Hg at 25 C. Both of these compounds act similarly chemically, but pentaborane hydrolyzes faster than does decaborane. The boranes are readily soluble in hydrocarbons but are only slightly soluble in water.

These hydrides of boron may enter the body by inhalation, by ingestion, or through the skin. After administration of decaborane intravenously to a dog, a rise in blood boron was noted for two hours but no boron was recovered in the urine.[10] Levinskas, in tracing the fate of decaborane in poisoned rabbits and dogs, found the boron content increased in bile, but a complete metabolic study was not done to determine whether all decaborane shared this fate. The failure to recover boron in the urine of the decaborane-poisoned dog may be partially related to the slow rate of hydrolysis of decaborane as well as to the small amount given to the dog. If further study reveals that boron does not appear in the urine in decaborane poisoning, then it would appear that decaborane is not converted to boric acid. (It is known that boron in boric acid poisoning does appear in the urine but that only negligible

amounts appear in the bile.[11]) It has been reported that the recovery from an acute intoxication by pentaborane in rats and mice is more rapid than from decaborane[12]; this may be related to the difference in their rates of hydrolysis.

Walton[13] demonstrated a direct effect of decaborane on the heart with a decrease in stroke force, a direct effect on the adrenals, and a definite clumping of erythrocytes. Wills[4] reported that electroencephalographic abnormalities occurred when the blood pressure fell in decaborane-poisoned rabbits, whereas cats showed abnormal encephalographic changes while the blood pressure was normal.

Svirbely[3] pointed out a strychnine-like effect in rats; that is, convulsive tremors were seen when animals were handled. Several of Rozendaal's cases and Lowe and Freeman's cases were suggestive of a strychnine-like response but only occasionally were the reflexes hyperactive.

Though it is apparent that the boranes are many times as toxic as boric acid, the symptoms of acute boric acid poisoning and the pathologic findings are suggestive of borane intoxication.[11, 14, 15] It is possible that the mechanism of action is the same, but the reactivity of the borane concentrates it at the site of action.

Levinskas[16] suggests that the boranes may exert their toxic effects by different metabolic pathways. This approach was suggested by the apparent separation of LD_{50} for the boranes into two distinct groups based on the milligrams of boron per kilogram rather than on the basis of milligrams of borane per kilogram.

Hill, Levinskas, and Merrill[17] compared the toxicity of the boranes with their reducing power and found that for the known boranes the reducing power paralleled the toxicity. That boranes may interfere with the oxidation-reduction mechanism has been considered, and attempts have been made with oxidative agents such as methylene blue, sodium thiosulfate, and pyridoxine to treat poisoned animals, without apparent success.[18, 19]

Pentaborane produces death acutely in rats when they are exposed to concentrations of 10 ppm for two hours.[12] Signs observed were weakness, incoordination, tremors, convulsions, corneal opacities, coma, and death. With repeated exposures all rats were dead in four days when exposed to 3.5 ppm, five hours a day for four days.[20] When exposed to 1 ppm chronically, all animals exhibited weight loss, nasal irritation, and incoordination.[21] When exposed to 0.2 ppm, monkeys were anorectic, with apathy, tremors, and decreased coordination. Dogs, rats, and rabbits lost weight but after six months revealed no distinct pathologic changes. Routine hematologic studies and urinalyses revealed no abnormalities, but liver studies showed occasional sulfobromophthalein (Bromsulphalein) retention, and elevated thymol turbidity and alkaline phosphatase values.

With decaborane, no death occurred with 95 ppm but the rats went into convulsions when handled.[12] Pathologically, there were corneal opacities, congested livers, congested lungs, and hemorrhagic adrenals. Signs prior to acute death were similar to those observed in pentaborane poisoning, but these signs persisted longer. At 4.5 ppm for 5½ hours a day for five days over a six month period, rabbits were very susceptible and died after a few exposures, whereas rats were very resistant.[22] Pathological changes in the dog were fatty liver, congested lungs, and tubular damage in the kidney, whereas rats showed no changes. The blood counts were unchanged in cats, and the laboratory studies on dogs showed no abnormalities of liver or kidney function.

Lowe and Freeman[8] described in great detail a case of pentaborane poisoning which certainly pointed out the toxicity of the higher hydrides of boron. Rozendaal presented the varied clinical features of the higher hydride exposures. In the severe case of Lowe and Freeman, there were semicoma, convulsions, hyperexcitability, disorientation and dizziness, with leukocytosis, hyperglycemia, elevated nonprotein nitrogen level, and evidence of liver damage. Though the number of cases tabulated is too small to permit valid conclusions as to the frequency of symptoms, dizziness and lightheadness are the most frequent, with headache, drowsiness, fatigue, and nervousness or apprehension commonly seen, and in the severer cases muscle twitchings and convulsions then appear.

The animal studies[4, 20] and also the clinical report of Lowe and Freeman suggest that pentaborane and decaborane produce similar effects. It would certainly appear that this could be true for compounds that are so similar; there may be some differences in intensity or in duration of action that will become apparent as more clinical experience is gained.

After a known exposure to a higher hydride, the onset of symptoms may be early or delayed as long as 24 hours. The clinical picture is quite varied, with the initial symptoms being lightheadedness, drowsiness, headache, extreme fatigue, or even muscle spasms, and all or any one of these complaints may be present. Usually the symptoms last one to three days, with the muscle twitching disappearing in 24 hours and then only lightheadedness and fatigue re-

maining. Upon examination in these cases there may be no abnormal findings or only a slight twitching of the muscles about the eyes or mouth. Occasionally the patient will be bent over involuntarily because of spasm of large muscle groups or the head may be turned as in torticollis, and these muscle spasms may or may not be associated with pain. Even in these cases, reflexes may be normal, certainly not hyperactive, but, interestingly, if the muscle group in spasm is put at rest, the spasm will gradually decrease. No muscle fasciculations have been seen, and stimulation of muscle groups does not increase the spasm or start a spasmodic contraction. The severer cases are as described in the article by Lowe and Freeman and Rozendaal. There has been no death due to borane intoxication and no evidence of direct cardiac involvement.

Animal studies have certainly confirmed pathologically that liver and kidney damage can occur,[12, 20] and Svirbely[3] demonstrated bromsulphalein retention for decaborane-poisoned dogs, and Levinskas[21] found suggestive evidence that this same test is altered in pentaborane poisoning. However, Svirbely's findings were on severely poisoned dogs, and Levinskas' report also dealt with obviously poisoned dogs. In these cases the pathological involvement of the liver and kidney was not striking. Similarly, in the first case report of Lowe and Freeman, there was definite evidence of liver and kidney involvement.

To evaluate liver and kidney damage, nonprotein nitrogen, cephalin flocculation, and thymol turbidity tests were run on a regular basis on the men working with the boranes and also when exposures occurred. The Lowe and Freeman report tabulates these results and points out that these tests reveal an increased number of abnormal values over that predicted in a population of this size. It was pointed out that many times the abnormal values were not associated with a known incident of overexposure. The possibility exists that these abnormals may represent subclinical exposures or that some other agent is causing the abnormalities. These laboratory studies were not helpful in confirming the diagnosis of borane intoxication because they were often negative in definite overexposures in which symptoms were present. A careful study of all workers with symptoms may clear up how frequently and how severely the kidney and liver are involved, but value would be limited because there is, at the present time, no practical way to decide that an exposure has occurred or to evaluate the severity of an exposure.

The urine boron excretion in the case described by Lowe and Freeman showed an elevation above 1μg per millimeter for only two days. (Levinskas[10] could not demonstrate that boron appeared in the urine of a decaborane-poisoned dog.) This may mean that the boron in the urine in this case came from some other source, possibly diborane or boric acid. In addition, Peiffer[11] states that the urinary excretion of boron continues six days or more in boric acid poisoning. In borane poisoning, if boron appears in the urine, excretion should take longer than in boric acid poisoning.

Intoxication by the higher hydrides may occur as a result of inhalation, by ingestion, or by skin absorption. Since it is apparent that these compounds are accumulative in the body or their effects are accumulative,[3, 21] then in any single case of intoxication, the route of entry will be difficult to determine unless some exposure incident can be incriminated.

In addition, because of the latency period before the onset of symptoms, the overexposure may be large. The odors of these compounds are distinctive, but since the men soon learn that symptoms do not necessarily appear because the odor is detected, they may remain in a contaminated area, and then since odor is the only warning and the olfactory sense rapidly becomes fatigued to this odor, poisoning can easily occur.

Amine Boranes

The amine boranes are a group of compounds which have a B-N linkage and are produced by reacting boron hydrides with amines. The amine boranes are very stable, hydrolyze very

Comparative Toxicities of the Boranes in Rats

Borane	LD_{50} Intraperitoneal mg/kg	LD_{50} Oral mg/kg	LD_{50} Percutaneous mg/kg	LC_{50}* ppm
Diborane (B_2H_6)				39
Pentaborane (B_5H_9)	11			18†
Decaborane ($B_{10}H_{14}$)	27	64.3	640	95‡
Dimethylamine borane $(CH_3)_2NH.BH_3$	50	59.2		
Trimethylamine borane $(CH_3)_3N.BH_3$	175			
Pyridine borane $C_5H_5N.BH_3$	73.6	95.4		

*Four hour LC_{50}.
†Two-hour exposure followed by a two-hour observation.
‡No animal died after an exposure.

slowly, are selective reducing agents, and have variable solubility in water. Examination of the table reveals the relative acute toxicities of these compounds.

It is apparent that dimethylamine borane is acutely toxic by ingestion and probably because of its solubility is as toxic orally as decaborane. Atmospheric levels could not be maintained at a sufficient level to produce deaths in rats with dimethylamine borane. When this compound was injected intravenously in a dog, it rapidly disappeared from the blood stream, and over 80% was recovered in the urine in the first 24 hours.[10]

As reviewed above in discussing the toxicity of the higher hydrides, it has been suggested that the decreased toxicity of the amine boranes as compared with the decaborane and pentaborane may be related to the decreased reducing power.

The intraperitoneal LD_{50} for dimethylamine borane is 50 mg/kg in rats and is approximately half as toxic as decaborane.[2] The rats showed progressive depression leading to coma and death was apparently respiratory. When dimethylamine borane is given simultaneously with decaborane, the effect is the algebraic sum of the toxic effects of each. When given in divided doses (20% to 40% LD_{50}), rats survived several LD_{50}'s but showed progressive paralysis and weight loss. When rats were exposed to 25 ppm six hours a day for 30 exposures, they showed only decreased activity and hair loss, but no deaths. When rats were pretreated with carbon tetrachloride, the acute toxicity of dimethylamine borane was increased by one third. Pathologically, dying animals revealed congestion of the liver and adrenals and hemorrhagic areas in the lungs. A 10% aqueous solution of dimethylamine borane produced slight erythema of rabbit skin, and a 10% aqueous solution also produced tearing, inflammation, and edema of the rabbit eye, which improved in 48 hours and was normal in 11 days.[23]

To date no case of poisoning by the amine boranes has been reported. For dimethylamine borane this can be related to its decreased toxicity, its low vapor pressure, and its rapid elimination by the body.

Treatment

The treatment of the pulmonary injury caused by diborane has been nonspecific. Oxygen under positive pressure is used because of the possibility of pulmonary edema and almost invariably the patients have stated that after oxygen therapy they felt better and that the tightness in their chests had been relieved. Usually their symptoms were subsiding by the time oxygen inhalations were started, and so it is difficult to state how much of the symptomatic relief is psychic. Though antibiotics have not been used, the possibility that a pulmonary infection may be present should always be considered, especially in any case in which the symptoms are prolonged.

At the present time, treatment of higher hydride poisonings is also nonspecific, but it should be noted that severely poisoned patients have made apparently complete recovery. In the most serious case of poisoning thus far encountered (reported by Lowe and Freeman) the patient has made an apparently complete recovery: at the present time in this same case there are no physical abnormalities, kidney function is normal (urinalysis, nonprotein nitrogen, and phenolsulfonphthalein excretion), and liver function studies reveal total protein of 6.6 gm per 100 cc, albumin: globulin ratio of 2.3:1, normal alkaline phosphatase and thymol turbidity, negative cephalin flocculation, total bilirubin level of 0.65 mg per 100 cc, and a 45-minute sulfobromophthalein sodium retention of 6.5%.

With the onset of symptoms in a known higher hydride poisoning, the use of phenobarbital for its anticonvulsant action may help decrease the likelihood of convulsion. With the onset of muscle tremors, spasm, and muscle pain, the use of a muscle relaxant such as robaxin can be tried. Early in the course of each serious poisoning by the higher hydrides, liver and kidney function studies should be done to determine whether these organs are involved.

Protection of Workers

Diborane can be detected by its odor at a concentration of approximately 3 ppm. The median detectable odor[24] for pentaborane is 0.8 ppm, and this odor has been described as resembling that of garlic or acetylene. The median detectable odor of decaborane is 0.7 ppm, and the odor is "chocolate-like" or "unpleasant." The MAC for diborane is 0.1 ppm; hence if the gas can be detected by its odor, the MAC is being exceeded. That does not mean necessarily that symptoms will be produced, but it does mean this concentration should not be inhaled continually. Workers state that their sensory perception of the odor quickly dulls, and so the chance of overexposure is increased. It is also known that pentaborane and decaborane can be detected in working areas and yet symptoms will not be produced in exposed workers. When these odors are present, the workers should leave the area or get respiratory protection.

Gas mask adsorbents have been investigated. Hill and Svirbely[25] found silica gel the most effective adsorbent for decaborane; Long and his co-workers[26] found that hopcalite was most effective for diborane and activated charcoal for pentaborane. A train of these three materials protected rats against a lethal concentration of a mixture of these three boranes. A canister containing these three materials is available commercially and will afford protection, but the maximum concentration against which the canister will be effective is not known. In addition, the life of the canisters at varied concentrations of boranes cannot be predicted. At the present time it is wise to rely only on a rebreather-type respirator or an air line mask when the concentrations are high.

Workers are required to wear long-sleeved clothing and eye protection, and when there is a real chance of spills occurring, rubber gloves and a face shield are used.[27] In case of skin contamination, a 3% aqueous ammonia solution has been used to complex the borane so that it can be then washed off the skin.[27] It is important to remember that the resultant borane complex should be considered toxic, and therefore vigorous washing is needed after irrigation with the ammonia water.

As an added protection, prospective workers are screened to eliminate those who may be more susceptible to poisoning. Examinations and chest x-rays are used to screen out applicants with chronic lung disease and allergy, and those with liver and kidney disease are screened out on the basis of history or abnormal laboratory studies (cephalin flocculation, thymol turbidity, nonprotein nitrogen, and urinalysis). Though there has been no evidence clinically that cardiac manifestations can be produced by boranes, it seems wise to screen out persons with evidence of heart disease until the toxicology is better understood.

Information Needed by the Clinician

At the present time, sufficient information is not available to determine that an overexposure to the boranes has occurred if it is not clear that the cause and effect are related. The worker will have many complaints, few objective findings, and there are no laboratory tests to aid in the diagnosis. The complaints of dizziness, headache, drowsiness, fatigue, nervousness, anorexia, and loss of memory are difficult to evaluate, and often the respiratory complaints are impossible to differentiate from an upper respiratory infection. Borane cannot be detected as such in the body, but blood and urine boron levels may be of value when sufficient data are available to serve as a baseline.

At the present time there is no means available to evaluate atmospheric concentrations of the boranes. Our experience up to the present is based on certain limited circumstances. When an overexposure occurs, the method of entry of the hydride into the body cannot be determined and therefore protective measures cannot be instituted intelligently.

In addition, an atmospheric monitor is needed to measure the concentrations to which workers are being exposed, and the concentration they can tolerate without effect. The threshold limits adopted by the American Conference of Governmental Industrial Hygienists for the boranes have value because they have assessed the relative toxicities of the boranes. These limits have only this theoretical value until they can be correlated with human experience.

Finally, although symptomatic treatment has thus far been successful, this may not always be the case in the future. A system of rational treatment is needed and this can be developed only when the mechanism of action of these compounds is known.

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Topical Review

Noise and Hearing Loss—Part I

Lieut. Cmdr. Norbert E. Rosenwinkel (MC), U.S.N.,
Kenneth C. Stewart, M.S., and Leo G. Doerfler, Ph.D., Pittsburgh

This is the first of a series of six reviews dealing with noise and its effect upon hearing. Subsequent installments are scheduled to appear at intervals of three months.

DURING the past decade, a lively interest has developed in the problem of industrial noise and its effect on hearing. This increasing emphasis is probably the result of a number of factors, not the least of which is the challenge to industry posed by the medicolegal aspects of the problem. Compensation laws deal specifically with noise-induced hearing loss in several states, and the potential wave of claims is already mounting. It is incumbent on the industrial physician to gain a clear understanding of noise-induced hearing loss so that, if conditions within his plant warrant it, he is able to establish a practical hearing-conservation program within the framework of present knowledge of the subject. It is the purpose of this series of articles to examine the subject of industrial deafness from the point of view of the industrial physician in order to equip him with the necessary basic concepts of noise and its effect on hearing.

General Principles of Sound

In order for the industrial physician to obtain a practical knowledge of the problem of the effect of noise on hearing, he must first become familiar with some of the physical properties of sound. Physically speaking, sound is a vibratory phenomenon which is transmitted through an elastic medium (for our purposes, air) as a train of alternating variations in pressure. For example, the rapid excursions of the cone of a loud speaker produce alternate compression and rarefaction of the air in contact with its surface. These alterations of pressure are transmitted through the air and, on reaching the tympanic membrane, force it into vibration. A simple demonstration of the wave motion of sound may be obtained with a child's coil-spring toy in which compression and rarefaction may easily be seen as a result of an oscillatory motion applied at one end. It has become a matter of convention to indicate sound waves as sine waves, with the upward deflections corresponding to compression and downward deflections indicating rarefaction, but this representation should not be interpreted as a literal representation of the movement of a given air particle in the path of a sound wave. In fact, particles are forced into a to-and-fro motion oriented along the direction of propagation of the sound wave.

Certain physical parameters are associated with the wave motion of sound. The amount of displacement of a given air particle from its resting position is the amplitude of the vibration. The movement of the particle from one point in a vibration to the corresponding point in the next vibration is termed a cycle and the number of cycles which occur in one second (cps) is the frequency. The distance between particles at corresponding points in adjacent cycles is the wave length.

A sound which can be characterized by the above qualities would be an example of a so-called pure tone or simple harmonic. If we strike a tuning fork, it always emits a tone of a given frequency and wave length regardless of the force of the blow. The amplitude, on the other hand, is dependent on the force with which the fork is struck and is a determinant of the intensity of the emitted sound. The force of the vibrating blow affects only the intensity of the sound and in no way changes the frequency.

Sound exhibits certain other attributes of

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The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

a physical nature. The velocity of sound in air is about 1,100 feet per second (fps). In more elastic media the velocity is greater; for instance, in water it is 4,700 fps. However, if no medium is present, as in a vacuum, sound waves cannot be propagated at all.

Sound obeys the law of inverse squares. That is, as the distance from the source is increased, the sound pressure varies inversely with the square of the distance. If the distance from the source is doubled, the intensity of the sound is reduced by one fourth and not halved.

Sound waves also exhibit absorption, reflection, refraction, and diffraction. Therefore sound waves passing through an interface of two media are in part absorbed, in part reflected, and the remainder transmitted, the proportions of each being dependent upon the differences between the two media. Sound waves falling on a soft fluffy material, such as fiberglass, are largely absorbed, while sound falling on a smooth plaster wall is largely reflected. Sound is diffracted to a greater degree than light, owing to its relatively long wave length. Indeed, it may flow around a fairly large obstacle much like water flowing around a rock. Sound entering a room through an aperture in a wall may fill the room just as though the sound originated from the aperture.

An understanding of the quantitative measurement of sound is necessary for the industrial physician, whose interests range from the barely audible tones used in the measurement of hearing to the relatively great intensities of noise produced in various industrial processes. This range of intensity when considered in physical terms is incredibly large. The loudest sound that can be perceived by the human ear without pain is about one trillion times as intense as the faintest audible sound.

As was mentioned before, sound waves consist of a series of compressions and rarefactions of air particles. An actual alternation of air pressure above and below normal atmospheric pressure occur as the sound wave passes a given point. This deviation of pressure about the normal is termed sound pressure and is measured in dynes per square centimeter (dyne/cm^2). One dyne/cm^2 is one millionth of the normal atmospheric pressure of 14.7 lb. per square inch and so is also called a microbar. It is the phenomenon of sound pressure which activates the ear drum in the process of hearing.

Intensity measurements of noise are usually in terms of the total energy contained in a sound wave or the energy density of a cubic measurement of air. These measurements are not so frequently used in the field of hearing conservation or noise control as are the sound pressure measurements referred to previously.

It has been determined that the weakest sound pressure that the average young person with good hearing can detect under good test conditions is 0.0002 dyne/cm^2 at a frequency of 1,000 cps. This minute sound pressure is used as a reference level for noise measurements, although many persons can hear weaker sound pressures in some circumstances.

As was pointed out above, sound pressures cover a tremendous range, the threshold of pain occurring at pressures of one million times greater than the threshold of hearing. Sound pressures occur which are even in excess of this level, but are beyond the range of normal hearing and can damage or even physically disrupt the organ of hearing after very brief exposure. It can easily be appreciated that in order to handle conveniently such a wide range of numbers, ranging from ten-thousandths to thousands, some other scalar arrangement must be adopted.

The method by which this wide range of values has been compressed to manageable proportions is the adoption of the decibel (db) system, originally used as a means of expressing the ratio between any two quantities of electrical or acoustic energy. Since acoustic energy is related to the square of the sound pressure, the decibel notation is readily adaptable to measurements of sound pressure. The decibel is a unit of comparison, or ratio, of two sound pressures and so has no dimensions or absolute values, as do most of the units of measurement to which we are accustomed, such as the centimeter, or liter. In order to be meaningful, it is necessary for a reference or standard to be established with which the sound pressures to be measured may be compared. This reference level should be clearly stated when a sound pressure is given in terms of decibels, for without a knowledge of the reference level such an expression is entirely meaningless. In actual practice, the reference level used in noise measurement is 0.0002 dyne/cm^2. This level is the reference against which sound level meters and other noise-analyzing equipment are calibrated. Thus when a noise level meter reads 65 db in a given environment the reading actually means that the sound pressure in the room is 65 db above 0.0002 dyne/cm^2 (65 db re 0.0002 dyne/cm^2).

Having stated the reference level, let us examine the actual computation of the decibel reading for a hypothetical situation. The decibel is derived from the bel, which is the common logarithm of the ratio of two electrical or acoustical intensities. Since the bel has

proved to be a rather large unit, the decibel, 1/10 bel, has been adopted. Also, since we are dealing with sound pressures rather than intensity, another factor of 2 is required owing to the fact that intensity is related to the square of the sound of pressure. Thus, given a sound pressure of P_1 and a reference pressure of P_2, the sound presssure level (SPL) is:

$$\text{SPL in db re } P_2 = 10 \times 2 \log \frac{P_1}{P_2}, \text{ or } 20 \log \frac{P_1}{P_2}$$

The factor 10 converts bels to decibels and the factor 2 expresses the relationship of intensity to the square of the sound pressure.

If, in a given instance, the ratio of sound pressures P_1 to P_2 is 1,000, by substitution:

$$\text{SPL in db re } P_2 = 20 \log 1{,}000$$

Since the logarithm of 1,000 is 3, in this case the SPL is 60 db re P_2.

As was mentioned before, the decibel notation reduces a vast range of sound pressures to manageable size. In the example above of a ratio of 1,000, the decibel value is only 60. If the range is increased 10-fold, the decibel value increases only to 80. Therefore, as pressure levels reach higher value, tremendous increases in pressure ratios will result in relatively smaller increments in decibel readings, owing to the logarithmic nature of the scale.

Having been concerned with strictly physical characteristics of sound, let us consider briefly two phenomena associated with sound which are actually psychological in nature, pitch and loudness.

Pitch is that property of sound which enables the hearer to place it at a definite level on the musical scale. Pitch is primarily associated with frequency and conventionally certain frequencies are assigned corresponding musical notes such as C 256 or A 440. However, at various levels of intensities, or with certain degrees of fatigue of the ear, a given frequency of sound may be judged by the hearer to be somewhat higher or lower on the musical scale.

Most sounds encountered in life are not pure tones but rather mixtures and combinations of various frequencies. Since no discussion will be presented here of musical intervals and harmonics, suffice it to say that sounds may be simple or complex, harmonious or discordant. Noise usually consists of complex discordant sounds of unrelated frequencies.

Any attempt to define noise in strict terms leads to great difficulty. Noise implies an emotional response on the part of the listener, and the most musical (in a physical sense) of sounds can well be considered as noise by unappreciative listeners. To cite a well-worn example, a phonograph record of a Beethoven sonata being played loudly at 11:30 P.M. is noise to the neighbor next door trying to sleep. Similarly the noise of machinery in a factory could well be "music" to the ears of the foreman of a shop which is operating efficiently. For purposes of discussion in articles of this series the generally accepted definition of noise as "unwanted sound" is acceptable.

Finally, let us consider the quality of loudness. Just as pitch is associated with frequency, loudness is associated with intensity. In general, the greater the intensity or sound pressure of a sound, the greater the loudness, However, since the ear is not equally sensitive to sound at all frequencies, sounds of various frequencies are not judged to be equally loud despite identical physical intensities.

The unit of loudness is the phon, which is defined as being equal to the decibel value re 0.0002 dyne/cm^2 of a tone of 1,000 cps. The decibel and phon are not interchangeable except at 1,000 cps. The loudness level of a tone of any other frequency is judged by comparison with 1,000 cps reference tones. Thus, a level of 20 phons at 100 cps actually possesses a SPL of about 50 db re 0.0002 dyne/cm^2.

The Structure and Function of the Ear

The human ear serves as a transducer which receives air-borne sound waves and converts them into neural impulses which are interpreted in the brain as sound.

The ear is divided anatomically into three parts. The first part is the external ear, including the pinna and the external auditory meatus, which penetrates the temporal bone and ends blindly at the tympanic membrane. The inner two-thirds of the canal forms a tunnel through the temporal bone (osseous portion), while the outer third is composed of cartilage (cartilaginous portion). The entire canal is lined by skin.

The middle ear is located within the petrous portion of the temporal bone. Its outer wall consists mainly of the tympanic membrane, while its inner wall is composed of bone, pierced by the oval and round windows opening into the inner ear. Contained within the middle ear are the auditory ossicles, three miniature bones, the malleus, incus, and stapes. The middle ear communicates with nasopharynx through the Eustachian tube.

The internal ear, within the temporal bone, contains the auditory sense organs, which are located within a spiral canal, the cochlea.

Sound reaching the external ear is collected and conducted by air to the tympanic membrane. On striking the drum membrane the sound waves cause this membrane to vibrate,

converting the wave motion to a mechanical force as the first step in the process of hearing.

The tympanic membrane is elliptical in shape, about 10 mm in height and 9 mm in width. It consists of three layers, the outer layer being skin and the inner of mucous membrane. The middle layer, the membrana propria, consists of fibrous tissue arranged somewhat like a spider web. The drum is drawn inward at the center and along its attachment to the handle of the malleus so that its lateral (outer) surface is concave. Point of greatest concavity, the umbo, corresponds to the tip of the handle of the malleus.

As the drum vibrates when stimulated by sound, the vibrations are transmitted directly to the malleus, and thence through the middle ear by means of a mechanical transmission system composed of the three ossicles to the oval window, into whose opening the footplate of the stapes is exactly fitted. The stapes is firmly attached to the circumference of the oval window by a ring of elastic fibers known as the annular ligament. Sound vibrations transmitted through the mechanical linkage of the ossicular chain are thus passed directly through the oval window to the inner ear.

Contained within the middle ear are two small muscles, the tensor tympani and the stapedius. The tensor tympani is inserted into the medial edge and anterior surface of the handle of the malleus. Contraction of this muscle pulls the handle inward and prevents excessive excursions of the tympanic membrane. The stapedius is inserted into the posterior of the neck of the stapes. Its action tilts the edge of the base of the stapes outward and thus reduces the pressure on the inner ear. These muscles contract by reflex action and thus serve as some protection against very loud sounds of a continuous type. Their action is too slow to be effective against sudden transient sounds. It is also interesting to note that the threshold for initiating this reflex is highest for the frequencies of 2,000 to 4,000 cps, which is in the range of greatest sensitivity of the ear.

The oval window is an opening in the wall of the cochlea. The cochlear canal, shaped like a snail shell, makes 2¾ turns around a central pillar, the modiolus. The canal is partially divided into two parts by a bony ledge, the lamina spiralis ossea. This division is completed by a fibrous membrane, the basilar membrane. Another membrane, Reissner's membrane, arises from the tip of the bony ledge and is inserted at a point above the insertion of the basilar membrane. The bony canal is thus divided into three galleries, from above downward, the scala vestibuli, the scala media, and the scala tympani. It is within the scala media that the sensitive hearing mechanism, the organ of Corti, is located. The essential sensory elements of the organ are the hair cells, which lie in a quadruple row along the entire length of the basilar membrane. The total number of hair cells is about 20,000. The free surface of each hair cell is surmounted by about 20 hairlike processes which are embedded in the under surface of the tectorial membrane, which overlies the organ of Corti.

The cochlea is filled with fluid, which conducts the sound stimulus from the oval window in the form of fluid waves. These waves are formed by the excursions at the oval window of the foot plate of the stapes. The hair cells respond selectively by frequency to the fluid waves within the inner ear. Those hair cells at the base of the cochlea respond to the highest frequencies, while those nearer the apex respond to lower frequencies.

The neural impulses which are generated in the hair cells of the organ of Corti are collected by fine arborizations of the cochlear division of the eighth nerve. Although the central connections of this nerve are not involved in hearing loss associated with noise exposure, it must be pointed out that it is not until the neural impulses reach the cortex that the various phenomena associated with sound are interpreted as the meaningful speech.

Frequency Response of the Human Ear

The human ear responds to the frequency range of 16 to as high as 16,000 cps. In young children and exceptional adults the response may extend as high as 20,000 cps. Beyond these extremes, an individual will perceive no sound regardless of the intensity of stimulation.

The ear is not equally sensitive to all sound frequencies. The most sensitive area is the range from 1,000 to 3,000 cps in which the average threshold of hearing approaches acoustical zero decibels (0.0002 dyne/cm^2). Below 1,000 and above 3,000 cps, the ear is considerably less sensitive, and higher sound pressures are necessary to reach the threshold of hearing. Sensitivity also decreases with advancing age, especially in the high frequencies, and adults unable to perceive sound of more than 12,000 or 13,000 cps are not uncommon. At the lower extreme of this range, the sound waves may actually be felt rather than heard if sufficient intensity of stimulation is achieved. Above the upper extreme, no sensation of hearing can be achieved regardless of the intensity of the ultrasonic waves. No damage to hearing due to exposure to ultrasound has been observed.

Editorials

A New Journal

The first issue of the JOURNAL OF OCCUPATIONAL MEDICINE is one of those original events which elicit special recognition, like the inauguration of a new government, the launching of a ship, or the beginning of a marriage. The conspicuous manifestations of this recognition traditionally are speech making and jubilation. But of greater significance for the success of the enterprise is another activity carried on less conspicuously: a serious matching of its purposes with its available resources. Permit us a little of each, the jubilant and the serious.

Our new journal appears at an auspicious point in time, as determined by three related but different circumstances. In the first place the journal's owner, the Industrial Medical Association, has gone through a long period of steady, solid growth, and is prepared for the responsibility of ownership and management of a major publication. Secondly, good medical service has come to be regarded as essential to an industry's success in the broad sense, in the extent that opportunities for the pursuit of this form of practice outnumber the available physicians with the necessary qualifications. And, finally, recognition has been achieved in areas of vital importance: specialty status has been granted to occupational medicine under the American Board of Preventive Medicine, and several major universities devote substantial resources to graduate training programs in this specialty. All of these accomplishments are important as solutions of major problems, and each in its own way makes easier the road for our new journal.

It is our purpose to present in one place the information which the practitioner of industrial medicine must have. This information will vary widely as regards detail, from articles that present analyses of original observations at one extreme to the superficial listing of contents in abstracts and book reviews at the other. The original articles will be selected on the basis of the quality of the work done, the authoritativeness exhibited, and their applicability to industrial practice. Besides the original articles, each issue will present reviews of broad topics, prepared by authors with experience in the areas covered. Certain of these topics will be sufficiently large as to require presentation in installments. Two such have been started in our first issue, one dealing with skin problems and the other with industrial noise. And, finally, we are determined to provide good literature abstracts and book reviews of some 12 to 20 areas that apply directly to or impinge upon industrial practice. It has been possible to accomplish only part of this coverage in the present issue. Other regular features will include case reports, information on meetings and training programs, committee reports, and Association news.

Our editorial pages will for the most part be used to draw the attention of readers to events and occasions of importance. From time to time editorial pieces will present and interpret the official actions of the Association as well as the collective views of its policy makers upon matters of practice and ethics so far as these can be determined.

The accomplishment of all of this must depend of course upon the prodigious efforts of a great many people. Our editorial board is a group of working editors, chosen for the contribution each can make to a well-rounded product. Authors of topical reviews as well as the abstracters and reviewers will be recognized at once as being among the most qualified persons to be entrusted with their particular responsibilities. In every one of these arrangements there has been enthusiastic willingness to take the assigned share of the total effort, accompanied in most instances by expressions of

encouragement that have been most heartening. One senses that there is a ground swell of determination that, having finally come into possession of a journal of our own, it must be the very best. Some 30 persons have contributed substantially to the text of this issue. This number will increase gradually, until finally the journal will reflect the determined effort of the Association's membership. This is the great resource we can bring to bear upon our objective.

The original articles presented in this first issue result from specific invitations to their authors. These papers were in each case completed in the face of overcommitments to other work during the same period of time. We are proud to offer them as expressions of support and goodwill by eminent colleagues.

Definition of a Specialty

A few years ago we accompanied a friend of ours who is a geographer—at least he was a university professor of geography at the time—to a public meeting at which he delivered an address entitled "Geopolitics in the Round World." On the presumption that light talk would be welcomed during the tension experienced even by professionals just before performance time, we wondered out loud upon the appropriateness of geopolitics as an interest for geographers, and this, in turn, led to a request on our part for a definition of the term geography. His confident response was that geography is what geographers do.

This pat answer often comes to mind during searches for satisfactory definitions of the interdependent terms occupational medicine and industrial medicine. On such occasions there is a temptation to paraphrase the geographer's reply and to assert that industrial medicine is whatever industrial physicians do. But we realize that this will not work.

Geographers have been around for a long time and have been counted with the intellectual giants in successive ages. Claudius Ptolemaeus of Alexandria not only presented the most accurate maps of the known world at the beginning of the Christian era but developed the new science. A millenium later, Albertus Magnus included geography as a discipline of his truly universal mind. And the general flowering of the intellect which characterized the 18th century produced the genius Alexander von Humboldt, whose observations and logic shed light on some of the fundamental geographic characteristics of the new world. So clearly established, then, has been this science as a result of centuries of performing obviously specialized work for well-understood purposes that self-assertion apparently is no longer a felt need among its practitioners.

The industrial physician finds himself at a different point in the history of his profession. Most of its development lies ahead. The specialty he practices will some day undoubtedly be clearly defined. The definition will be based only in part upon what this new specialist does and the kinds of problems he solves. For the rest, a full definition will be concerned with the new areas he probes with his research and the kinds of competence he demands of himself and the young associates who are moving in to replace him. His own definition, for his own use, will be based upon these things as he sees them. But the definition accorded the specialty by the total body of physicians engaged therein, as well as by those who look upon it from the outside, will depend upon what is presented to the general, public view. This presentation is the mission of the JOURNAL OF OCCUPATIONAL MEDICINE. We are determined that it shall be done adequately, in an interesting fashion, and with fairness and honesty.

Beginners' Corner

In our reasonably wide acquaintanceship among industrial physicians are several who have impressive first-hand experiences in the health aspects of one or another circumstance of employment, but who have never presented their special knowledge in print. In some cases, this dereliction is undoubtedly due to restrictive industrial policies; but in others the explanation must have to do with a list of personal reasons. Prospective authors of this kind are invited to correspond with this journal's editor, submitting in outline form a summary of a proposed paper. Each such outline will receive serious study by one or more members of the editorial board with the hope that timely modifications or further development will result in the appearance on our pages of the works of a long list of new authors.

Industrial Medical Association

THE PRESIDENT'S MESSAGE

H. W. LAWRENCE, M.D.

WITH THIS issue the President's page moves into its own home—a journal owned, published, and managed by our Association. We haven't had time to compare our new lodgings with those we have just left, nor with others we have known for a long time, but it's ours, we feel at home, and we like it.

This event culminates a series of actions begun by your officers and directors more than a year ago. We were determined to have our own journal. Other measures failing, a decision was taken last April to start an entirely new publication. Its key editorial and business personnel were selected in the early summer, and plans for the present issue were got under way at once. Printing arrangements were accomplished in the late fall.

It is in the nature of the journal publishing business that most of the costs of production are borne by the sale of advertising pages. Common sense tells us that a satisfactory sales level of this commodity will take some time to develop. We are quite prepared, despite a restricted income during start-up time, to produce a first class periodical right from the beginning. We are encouraged to believe that this portion of the new publication's problems will shortly find favorable solution under the direction of our able publications manager.

We must plan now for the day when the financial health of our journal will tolerate a greatly expanded number of text pages. District counselors and component society officers must be continually alert to the possibility of obtaining for review those papers presented in their respective regions which are likely to be of value to our journal. All members with discoveries of this sort are asked to transmit them directly to the journal's editor. The program arrangers of our annual meeting will continue as heretofore to plan presentations for their timeliness, intellectual content, and applicability, but henceforth will be sensitive for a fourth characteristic of a paper — its likely usefulness as an article in our journal.

We expect to present a lively news section about people and events of importance to industrial medicine. We shall rely for this material largely upon the Association's unpaid, amateur reporters—its members. News items should be mailed directly to our headquarters office.

We would draw your attention to the last editorial in this issue, entitled Beginner's Corner. This deals with the implication that a great benefit can accrue to this journal from the application of its editorial talent to the development of new writers, or to the upgrading of self-judged second-class writers to publicly acclaimed first-class ones.

There is work ahead in this venture for a great many members who have not as yet been asked to help. If we know anything at all about our editor, it is that once he becomes involved in a project he very shortly has a great many people working with him. We see this happening already, with a number of people talked into doing jobs they really haven't time for. If you haven't been asked to do some chore, enjoy the respite. Your time will come soon enough.

Book Reviews

INDUSTRIAL MEDICINE IN WESTERN PENNSYLVANIA 1850-1950. T. Lyle Hazlett, M.D., and William W. Hummel. Price, $6.00. Pp. 301. Pittsburgh, University of Pittsburgh Press, 1957.

The authors in their epilogue write: "The route travelled by industrial medicine in Western Pennsylvania . . . has been a journey from ignorance, uncertainty, and primitiveness to scientific knowledge, understanding, and efficiency in preserving the health of the industrial worker; from the frequently despised company or 'contract' doctor to the highly respected industrial physician; from primitive first-aid treatment of injuries to highly scientific procedures of preventive engineering; from the uncertainty and inconvenience of court decisions under employer liability laws to the relative security of workmen's compensation supplemented by sickness and accident benefits. It is the story of a steady movement from the simple concept that industrial medicine's sole concern was the treatment of traumatic injuries to the complex idea that anything which may have an adverse effect on the physical and mental health of the industrial worker is the concern of the industrial physician."

This volume was four years in preparation. Its statements are documented by a mass of literature, interviews, and illustrations. Effectively it lays the backdrop of modern-day industrial health practice in one of America's greatest heavy industrial areas.

The senior author is widely recognized in the field of industrial medicine in its modern development. He was one of the influential men in determining the recognition of the preventive medical phase, the medical engineering, the medical relations, and the mental hygiene phases in industry. His work began in one of the big corporations of western Pennsylvania after World War I and extended into the area of education in the form of both health education of the industrial workers and professional education in this field for the physicians, nurses, and engineers. He was a staunch advocate of the horizontal, or interdisciplinary, staff approach to the solution of occupational health problems in the industrial setting.

The book reads easily and interestingly. After laying the early background of industrial medicine in western Pennsylvania, it divides itself into four phases: surgical, preventive medicine, medical engineering, and medical relations. In unfolding these in separate chapters, there is a tendency toward repetition.

Perhaps the most interesting chapter is that on mental hygiene in industry. Here is an area we think of as being quite new today and yet its development goes far back. Even in so rough and tumble an area as the heavy industries of coal, steel, and railroads in western Pennsylvania, there rose in their midst the early applications of good mental hygiene principles.

The H. J. Heinz Company, under the benevolent influence of its founder, introduced the "industrial family" idea into his rapidly developing food processing plant. He was strongly influenced by the social legislation in Germany under Bismarck. In 1875 Mr. Heinz appointed Mrs. Agnes Dunn to be in charge of all women employees, and for more than 50 years she served as "mother" to the girls of the Pittsburgh Plant. This book tells the work story of "Mother" Dunn in a most delightful and enlightening manner.

"Although the medical facilities, safety and sanitation programs and general working conditions in the H. J. Heinz Company were among the most advanced in Western Pennsylvania, their influence upon other industries in the area was relatively small. The reason for this is readily apparent. Pittsburgh's economy was geared to the steel ingot, not the pickle and, therefore, it was the medical programs of the steel companies which were to have the greatest impact on the development of industrial medicine in Western Pennsylvania."

The book is richly interspersed with delightful anecdotes which so aptly express the social attitudes of their period. For example, the troubled fears and frustrations of the industrial worker of the 1910 era can hardly be told more humorously and yet pointedly than they are portrayed in Crystal Eastman's enlightening essay as quoted in this volume. "In a humorous monologue Mrs. Leary conveys a feeling common to families of industrial workers who worked in major industries in Western Pennsylvania about 1910.

"Oh yis," said she, "the docthers say ye can't kill Andy,—but I know betther. He'll be a-coming home dead soon. Ivery time I hear a knock at the dhoor, I thinks to mesilf, 'There, now,—it's thim, comin' to tell me Andy's kilt.' Andy, he jokes about it. Only this marnin' after I'd been givin' him his breakfast, he starts to go to work out the back dhoor, an' I says, 'Andy why don't you niver go out the front dhoor?' 'Oh, Leary,' says he—(that's what he calls me—Leary), 'Leary' says he, 'the back dhoor's good enough for me, I'll be a-comin' by the front dhoor soon enough, an' I won't be walkin'."

D. JOHN LAUER, M.D.

READINGS IN MEDICAL CARE. Edited by the Committee on Medical Care Teaching of the Association of Teachers of Preventive Medicine. Foreword by George Packer Berry, M.D., Price, $6.50. Pp. 703, with an index. Chapel Hill, University of North Carolina Press, 1958.

A comprehensive selection of professional writings on our country's medical care characteristics and problems has finally appeared. It is full of data—and expressions of viewpoint—on the organization of medical services, and their social and their technical backgrounds. No longer need one search for, and not find, a single review book on medical care organization.

The book's basic intent has been to draw together in systematic and orderly arrangement the

most important writings in this field of the last 25 or so years. Nothing printed later than 1956 is reproduced, because, as the preface says, "Some time must necessarily elapse before the permanently valuable books and monographs issued yearly in the medical care field can be identified." Many of the writings reproduced here have been available heretofore only in obscure or out-of-print publications.

The chapter heads may give best the flavor of the type of subject covered. They are: Problems in Medical Care: The General Background, The National Health Picture, Adequacy of Medical Care, The Costs of Medical Care, The Medical Care Team, Hospitals, Coordination in Health and Medical Service, Care of Long-Term Illness, Rural Medical Care, Public Medical Care, Medical Care in Industry, and Medical Care Insurance.

A brief introductory statement to each chapter by the editors puts the subject in proper context. Footnotes to each article identify the author and supply current data on subjects treated in it, a most valuable editorial addition.

The penultimate chapter will, of course, be of special interest to readers of the JOURNAL OF OCCUPATIONAL MEDICINE. A one-page editorial introduction to it reminds us of significant facts, such as that "the acceptance by industry of concern for non-occupational disease and injury in recent years marks a development of great importance. It has been spurred on by the inclusion of health and welfare benefits in collective bargaining." Subsequently, excerpts of the following articles are presented:

1. "Medical Care in Industry," a 1951 paper by Dr. William A. Sawyer.
2. Provisions for In-Plant Care, through a 1943 paper by Dr. O. F. Hedley.
3. "Successful Prepaid Medicine in Industry: A Complete Industrial Medical Program," by Drs. Charles M. McGill and Sherman S. Pinto from the September, 1952, *Industrial Medicine and Surgery* (not an obscure publication).
4. "Medical Care Insurance for Industrial Workers," a study in 1951 of organized labor's attitude toward prepaid medical care, by Dr. Walter J. Lear.
5. "United Mine Workers of America Welfare and Retirement Fund Medical Care Program," a 1953 description by Dr. Warren F. Draper.
6. "Labor Health Institute Medical Care Program," St. Louis, Mo., by Dr. Elmer Richman in 1949.
7. "Medical Service in Industry and Workmen's Compensation Laws," by the American College of Surgeons in 1946.
8. "State Workmen's Compensation Laws as of September 1950," by the U. S. Department of Labor.
9. "Medical Services in Workmen's Compensation in the U. S.," by Bruce A. Greene (1954).
10. "Rehabilitation in Workmen's Compensation in the U. S.," by Jerome Pollack (1954).
11. "Sickness Disability Insurance and Preventive Medicine," by Leonard J. Goldwater (1950).

Perhaps the reader would have chosen other selections to tell the story. In a way this reviewer feels the same way, too, because none of what he considers his own most praiseworthy articles have been chosen. Since he was an active participant in preparing the "Readings," this shows admirable restraint by the editors—or delusions by the author. However, it cannot be denied that the articles selected have much to say, and they represent remarkable balance among the vast numbers that had to be considered.

The project was really a remarkable one. It aimed to produce a much needed teaching aid—and hit a bull's-eye. It did this through a cooperative effort involving dozens of persons and sponsorship by a committee of an Association. But in so doing, *mirabile dictu* it has developed a book with unity. Further, it has actually defined a consensus among its creators as to what the field of "Medical Care" is. It established sound criteria for what could be considered a professional level of writing in the field. Finally, it demonstrates how all points of view could be presented in a balanced manner.

Those who worked on the "Readings" joked about the fact that it "had the longest gestation period in history." It took many years to plan, compile, revise, and complete. Many organizations and individuals contributed funds to bring it into existence. The Josiah Macy, Jr. Foundation especially helped as midwife through a publication grant, enabling the price to be set as low as it is. But the prolonged labor has resulted to a lusty, attractive infant.

Industrial physicians and nurses, industrial hygienists, and their professional cousins will need to know this book and to have it promptly available for reference if they wish to help their thinking in today's fast-moving developments. Tomorrow will soon be upon us and will necessitate a second edition of this helpful compilation.

LESLIE A. FALK, M.D.

NEW CHEMISTRY. A selection of articles from *Scientific American*. By various authors. Paper. Price, $1.45. Pp. 206. Simon and Schuster, Inc., Rockefeller Center, 630 Fifth Ave., New York, N.Y., 1957.

This book, designed for the general reader, may presumably be reviewed by a general reader. It is one of a series of 10 developed from articles which regularly appear in *Scientific American*, the 9 other titles ranging alphabetically from "Atomic Power" to "Twentieth Century Bestiary" (we had to look it up too!). The parent journal is required reading for the professional in any field with a need to maintain some semblance of literacy in the burgeoning areas of science about him. The technique of rewriting into universal prose by professional editors the authoritative works of leading specialists in all branches of the natural sciences has probably

been raised to its apogee by *Scientific American*. The articles chosen for the present compendium bear this characteristic.

The book is divided into four sections, entitled New Reactions, New Methods, New Elements, and New Compounds. Each section, in turn, presents four subjects. Industrial physicians who serve the atomic energy industry or the chemical industry will find most of the subjects directly applicable to their work. Others will find them well chosen for their variety and the aspects of the new chemistry which the articles describe. And still others will find, in clear and simple language, expositions of topics that are becoming part of industrial practice, such as chemical analysis by infrared and chelation in the section on New Methods. True, these are not areas in which the industrial physician must have a capacity to perform; but they are areas in which a growing number find it necessary to achieve literacy.

The infrared region most useful to the chemist is the range of wave lengths from 2μ to 20μ, sometimes called the vibrational region. Waves of this length pass through molecules, creating an oscillating electric field among the atoms that comprise the molecules. When the frequency of this oscillation corresponds with the natural frequency of vibration of the bonds between atoms of the molecules, a portion of the wave energy is absorbed. The pattern of absorption is specific not only for a molecule but for the atoms and radicals that compose it as well. Even geometrical isomers of the same compound can readily be distinguished.

Chelation is the selective binding of metals by ring-shaped molecules that contain two or more electron donor atoms. The acceptance of these electrons has the effect of being grasped by a claw. Calcium EDTA produces this effect in its selective binding of lead or plutonium atoms, and EDTA alone will chelate calcium from bone or kidney stones.

For those uninterested in the theory of the new chemistry as such, the section on New Compounds has fascinating chapters on silicones, fluorocarbons, rubber, and detergents.

ADOLPH G. KAMMER, M.D.

THE INSTITUTE OF INDUSTRIAL MEDICINE

NEW YORK UNIVERSITY POST GRADUATE MEDICAL SCHOOL

offers a course on

RADIATION HYGIENE MEASUREMENTS

May 4-29, 1959

A laboratory course for persons having some acquaintance with nuclear measurement principles. Experiments will include work with neutron sources and mixed radiation fields. Considerable attention will be given to shielding experiments involving gamma radiation, neutrons and beta radiation.

Abstracts of Current Literature

Medical Care Administration

Asa Barnes, M.D.

Twenty Years in Retreat Workmen's Compensation. Labor's Economic Review. Published by AFL-CIO 3:49-55 (August-September), 1958.

American workers today believe when they are injured on the job that medical care will be furnished them as long as they need it; rehabilitation will be provided to the extent necessary to give them every opportunity to overcome as much of their disability as possible; and cash benefits will be paid in amounts adequate to maintain a reasonable standard of living for themselves and their families for the duration of the disability or dependency. Actually, today millions labor unprotected by workmen's compensation laws. Only three out of four workers are so protected against the risk of income loss and medical costs. Approximately half of the states provide compulsory workmen's compensation coverage. The remaining states permit election of coverage in one form or another. Mississippi, Wyoming and Montana make no provision for workmen's compensation for persons injured by an occupational disease. An additional 18 states and territories limit coverage to a schedule of occupational disease. The rapidly increasing use of atomic energy for peaceful purposes has exposed many workers to injury different from other occupational diseases. Today, no state can say all regularly employed workers are afforded protection against the hazards of injury on the job. One-fourth of the states still limit by amount or time the medical care furnished workers suffering "accidental" injuries and half of the states still limit the medical care for those who incur occupational disease. Three-fourths of all workers covered by workmen's compensation must today accept the physician chosen by the employer or his insurance carrier. Workmen's compensation should be dedicated to the proposition that injured workmen should have every opportunity to overcome as much of their disabilities as possible. However, few states have attempted to provide adequate rehabilitation programs.

The Effect of Competitive Industrial Activity on Severely Disabled Cardiac Patients. Alvin Slipyan. J.A.M.A. 168:147-153 (Sept. 13), 1958. (Albertson, New York)

Employers are reluctant to hire cardiacs even if they do not have a definite policy against it. Only 8% of the physicians surveyed considered cardiac patients to be unsafe workers and only 3% considered them to be inefficient. The absence of any detrimental effect of employment on the disease state is well documented in the literature and the remarkable improvement exhibited by some of the employees makes one wonder whether the dictum that the person with severe cardiac disease requires constant rest and should retire from employment might not be revised to: Employment in a compatible job can, in a specific case, be beneficial. The elimination of fear about heart disease is one of the major problems faced by the physician in his effort to rehabilitate patients with cardiovascular disease.

Does the Executive Health Program Meet its Objective? L. E. Prickman,* G. A. Koelsche, J. M. Berkman, H. M. Carryer, G. A. Peters and L. L. Henderson. J.A.M.A. 167:1451-1455 (July 19) 1958. (*Section of Medicine, Mayo Clinic and Mayo Foundation, Rochester, Minn.)

This is a follow-up study of examinations of 231 management executives, each of whom had undergone at least two examinations at the Mayo Clinic. They were studied to determine the various medical and social conditions encountered and then to evaluate the extent to which the employee complied with advice given for the correction of these conditions.

Compliance and partial compliance amounted to 80% after the first visit, 87% after the second visit and 90% after the third visit which tends to show that with passage of time and repetition of advice on subsequent examinations an increasing proportion do comply to a greater degree in following advice.

It would seem that most patients of the management personnel group are sincerely interested in carrying out the health measures prescribed for them and thus in attaining the objective of the executive health program.

UMW Report for the Year Ending June 30, 1958. By UMW of a Welfare and Retirement Fund, 907 Fifteenth Street, N.W., Washington 5, D.C.

Approximately a million beneficiaries are currently covered by the Fund. Hospital and medical services currently in effect include hospitalization for the length of time necessary in the opinion of the attending physician, physicians' services and drugs in the hospital, specialist services on an in-patient and out-patient basis, physical rehabilitation services and certain costly drugs requiring long continued use outside the hospital. A total of 85,426 beneficiaries received these hospital and medical care benefits. All ten Miners Memorial Hospitals have been accepted for accreditation by the Joint Commission on Accreditation of Hospitals. Any physician qualified legally, professionally and ethically to practice medicine is eligible for appointment and is encouraged to become a member of the hospital staff. A School of Practical Nursing, a School of Professional Nursing and a School of Medical Technology, have been organized. Residency

training programs in internal medicine and surgery have been established. Limited grants for research projects have been made available and a large number of clinical studies are under way. Pensions were paid to a total of 64,367 retired miners. Benefits were paid to 10,540 widows, orphans, and other eligible survivors of deceased miners. Administrative costs of this Trust Fund, including those of its Washington headquarters and its ten area offices, were only 2.8% of the total expenditure.

Industrial Hygiene

Edward C. Riley, M.D.

Urinary Arsenic Levels as an Index of Industrial Exposure. H. H. Schrenk* and Lee Schreibeis, Jr. Am. Indust. Hyg. A. J. 19:225, 1958. (*4400 Fifth Ave., Pittsburgh 13)

In this study the authors explore the usefulness of urinary "arsenic determinations as a measure of industrial exposure to and absorption of arsenic." They hoped to establish a level of urinary arsenic which would warn of increased exposure as well as a level which might suggest impending intoxication similar to the standards which have been recognized for lead.

Although they were able to establish normals for their plant population, the rather dramatic elevation in urinary arsenic after the eating of certain seafoods tends to obscure the effect of industrial exposures. They conclude that "in unexposed persons one may expect the urinary arsenic level in the majority of persons to be less than 0.1 mg/liter with a few values in excess of 0.2 mg/liter unless there is some specific arsenic intake in the diet."

They give no indication of a toxic level but feel that "urinary arsenic levels in a group of exposed persons may serve to check the efficiency of control measures and indicate if excessive absorption of arsenic occurs. However, the occurrence of a high value in an individual is not evidence of industrial exposure."

A Particle-Sizing Method for Aerosols and Fine Powders. R. L. Dimmick, et al. Arch. Indust. Health 18:23, 1958. (Naval Biological Laboratory, School of Public Health, University of California)

The authors have adopted recognized optical techniques to provide a relatively simple method of following changes in both concentrations and equivalent particle sizes (or mass median diameters) of aerosols and fine powders. As they point out, this should provide a method for evaluating the dynamics of the aerosol without disturbing its characteristics. This should be a valuable tool for investigators studying the respiratory effects of aerosols.

NOTE: Such techniques have generally proved unsatisfactory for evaluating plant atmospheres where the type and composition of contaminants are variable and not controlled.

A Large-Volume Electrostatic Air Sampler. S. C. Stern,* et al. Arch. Indust. Health 18:30, 1958. (*General Mills, Inc., Minneapolis)

The application of electrostatic precipitation to continuous air sampling for particulates is unusual in industrial hygiene sampling. Although most of the industrial exposures to dust and aerosols have not demanded this type of continuous sampling, there has always been a need for more information on fluctuations in concentrations as well as over-all average concentrations. The described sampler concentrates the particulates from at least 100 liters of air in 1 ml of liquid.

Safety Evaluation Procedures and Interpretations. Henry F. Smyth, Jr. Food Technol. 12:17, 1958. (Mellon Institute, 4400 Fifth Ave., Pittsburgh 13)

This article is a well thought-out discussion of the safety evaluation as related to food additives. The author points out that the well-defined experimental technique for evaluating safety suffers from "attempting the logically impossible task of proving a negative and does not necessarily determine any important qualitative fact about the potentially injurious action of an additive," and attempts "to compensate for the short comings of the technique and ignorance by use of variable arbitrary safety factor. It is possible to plan a rational approach to safety evaluation, consisting of experimental studies which can yield positive information more valid in both a qualitative and quantitative sense than our present procedures."

NOTE: The problem of food additives differs from industrial hygiene problems in that it presupposes that there is a reason or need for the additive in the first place and that the concentration in the food can and will be carefully controlled. In industrial hygiene exposures it is unlikely that control can be maintained with anything like the same degree of certainty, and we shall always have to rely on a considerable factor of safety or ignorance in establishing allowable concentrations for environmental exposures.

Testing Laboratory Hoods—Evaluation of Design Changes and Periodic Performance Testing. N. H. Ketcham. Am. Indust. Hyg. A. J. 19:324, 1958. (Union Carbide and Chemicals Company, South Charleston 3, West Virginia)

This article by a member of a large industrial organization brings out some of the weaknesses frequently encountered in industrial hygiene control ventilation and emphasizes certain changes in the requirements of industrial hygiene exhaust ventilation. The author points out that with the increasing trend towards air conditioning in laboratories and production areas, "the hoods are the main means of removing this air, thus they are now being recognized as an essential (or integral) part of the air conditioning and ventilation system.

"There are two fields of effort which need to be given more attention. One of these relates to bridging the gap between the engineer who de-

signs hoods and the laboratory personnel who use them. Frequently the hood is not used in a manner to take full advantage of the protection it could provide. The other field which needs greater attention has to do with adjusting the hood for proper operation when it is first installed and then following this with periodic testing and maintenance to keep it operating effectively."

The author points out the need for a simple test which can be periodically performed while the hood is in actual use and which will give a quick indication of whether or not the hood is performing its designed function. He discusses the frequency of repeated tests and methods of recording data to permit ready comparison between consecutive tests and for follow-up studies on all the hoods in the given laboratory.

The author points out the need for allocating the responsibility for "keeping laboratory hoods functioning in a satisfactory manner and for giving instructions regarding the proper way of using the hood." In his organization the responsibility usually falls on the laboratory service group, which has the responsibility for keeping the laboratory hoods operating effectively and efficiently.

NOTE: The problem of evaluating the performance of industrial hygiene control ventilation, both in the laboratory and in the plant, is certainly an important and continuing one. Whether or not the same group who is responsible for the maintenance of the equipment is in the best position to evaluate the performance is a question on which there is little agreement and which will certainly vary from organization to organization.

Radiation Health

Thomas S. Ely, M.D.

An Evaluation of the Somatic and Genetic Hazards of the Medical Uses of Radiation. Henry S. Kaplan, Am. J. Roentgenol. 80:696-706 (Oct.), 1958. (Department of Radiology, Stanford University School of Medicine, San Francisco)

Along with natural background ionizing radiation, medical radiation contributes the largest part of the dose received by the general public. Radiologists have been aware of the problem of overexposure for many years, but recent reports on the effects of low-level radiation and improved estimates of the doses received by the general public have stimulated increased public awareness of the problem and a need for increased attention to the matter by the medical profession. A review is presented of some of the pertinent and controversial literature on the genetic and somatic effects of radiation. Results of personal research on the effects of antepartum pelvimetry on the incidence of leukemia in childhood are presented. Correlation is or is not significant, depending on whether siblings or playmates are used as controls. The conclusions should be of minor importance, however, as the availability of antibiotics and careful obstetrical management mean considerably less need for routine pelvimetry now than formerly. Evidence is presented and discussed which refutes the linear theory of somatic effects of radiation, such as leukemia, osteogenic sarcoma, and life shortening, but there seems good reason to assume that genetic mutagenesis has no threshold. It is pointed out that the medical profession has long been adding to the mutation burden by the treatment of defectives and that the genetic consequences of medical radiation should be judged in this light and also that of the potential benefit to be derived from the procedure. However, reasonable measures to reduce medical radiation, such as collimation, filtering, shielding, discouragement of fluoroscopy, and weighing the indications, should be taken.

Acute Clinical Effects of Penetrating Radiation. H. B. Gerstner, J.A.M.A. 168:381-388 (Sept. 27), 1958. (Department of Radiobiology, School of Aviation Medicine, Randolph Air Force Base, San Antonio, Texas)

The experience at Hiroshima and Nagasaki can be correlated with clinical information from other sources (reactor accidents, exposures to radioactive fall-out, and experience with patients undergoing radiotherapy) to predict some of the hospitalization needs of a population in the event of a nuclear holocaust. Victims can be classified as to the form of acute radiation syndrome they manifest, whether cerebral, gastrointestinal, or hemopoietic. Deterioration is fastest, prognosis worst, and hospitalization least helpful in patients with the cerebral form. The hemopoietic form, by contrast, has a latent period of about three weeks between recovery from the prodromal sickness and onset of the leukopenia and hemorrhage; the prognosis is best and hospitalization most likely to be effective. The gastrointestinal form is intermediate as to duration of latent interval, likelihood of recovery, and effectiveness of hospital care. The hemopoietic form of acute radiation sickness is likely to pose the major problem. The height of hospital occupation then should be reached during the fifth and sixth weeks after exposure, and medical authorities will probably have sufficient time to plan the necessary countermeasures.

Where Are the Cases of Radium Poisoning? S. D. Clark, J.A.M.A. 168:761-762 (Oct. 11), 1958. (Radioactivity Center, Massachusetts Institute of Technology, Cambridge, Mass.)

There are probably about 2,000 radium dial painters from the early 1920's still living, together with several hundred other persons who drank radium water or had injections of radium salts during the period 1915-1930 for such conditions as arthritis, hypertension, and gout. These individuals all still carry a certain amount of this radium in their bodies, and potentially form an important source of information not otherwise obtainable on the long-term effects of radiation on the human. Knowledge

of the effects of radium on these people could materially assist the evaluation of the hazards of strontium-90 and other radioactive isotopes.

Previously available records have befallen a series of tragic destructions, and there is now a serious shortage of information on the identity and whereabouts of the cases. The Radioactivity Center has been set up at the Massachusetts Institute of Technology to collect, integrate, and keep intact, records of all cases of chronic radiation poisoning in human beings by certain internally deposited alpha emitters. In the absence of a history of exposure, chronic radium poisoning may be suspected in cases of spontaneous fractures without evidence of a neoplasm at the site, osteogenic sarcomas, neoplasms of the paranasal sinuses, generalized demineralization of bones, and early loss of teeth. A plea is made for the submission of case information for registration in the Center. Cases will be discussed individually, and the existing doctor-patient relationship will not be jeopardized.

Critique of the Linear Theory of Carcinogenesis. A. M. Brues, Science 128:693-699 (Sept. 26), 1958. (Argonne National Laboratory, Lemont, Ill.)

That cancer can be induced by large doses of ionizing radiation is above question. Whether induction rate is linearly related to dose at low levels is of limited interest when a small group is considered but assumes considerable importance when a very large population is exposed to a very small dose. In this case, if a linear theory is correct, a small percentage, but considerable number, of individuals would be affected. If a nonlinear relationship with a threshold is involved, no effect would be expected. The linear theory must be based on a single-event hypothesis. If multiple events are required, the relationship cannot be linear, and if tissue disorder is a factor, a true threshold may be the case. Many studies are reviewed which either refute or fail to offer support for the linear theory. These include the leukemia incidence in Japanese survivors, induction of lymphoid tumors in mice, dose rate sensitivity in laboratory studies and in radiologists, leukemia-protective effect of partial body shielding and of bone marrow transplantation, and the fact that thymic tumors are induced in the unirradiated thymus transplanted to the irradiated mouse. The single-event theory is further challenged by the Court-Brown and Doll spondylitis cases, by the fact that early cancer is usually multicentric, and by the fact that mouse and human natural and induced cancer rates are similar in spite of a cell number ratio of about 1,000.

Possible Health Hazards Associated with the Laundering of Radioactively Contaminated Protective Clothing. S. G. Pearsall,* L. Gemmell, and A. Breslin, Health Physics 1:176-183 (Sept.), 1958. (*Health Physics Division, Brookhaven National Laboratory, Upton, N.Y.)

The laundering of radioactively contaminated clothing is a matter of practical industrial concern. Studies at the Brookhaven National Laboratory decontamination laundry showed that contaminated clothing transfers activity to laundry surfaces, waste water, laundry and surrounding environmental air, lint, and laundry machinery, and that the machinery then contaminates clean clothing. The effect of greatest potential hazard was that of contamination of laundry air. Respirators are used as a matter of routine when sorting or loading clothing. Other potential hazards depend on several parameters, and their determination is essentially a matter of individual quantitative evaluation. With old mixed fission products, clothing contamination below 1-2 mc per garment could be sent to a commercial laundry and handled routinely without hazard to laundry operators or the public. A special large-area multiple Geiger tube instrument was constructed for the purpose of monitoring the clothing. Available survey instruments do not cover sufficient area to perform this service satisfactorily.

Experimental Toxicology

Robert E. Eckardt, Ph.D., M.D.

Protection by D-Penicillamine Against the Lethal Effects of Mercuric Chloride. H. V. Aposhian.* Science 128:93 (July 11) 1958. (*Department of Pharmacology, Vanderbilt University School of Medicine, Nashville, Tenn.)

Although BAL completely protects rats against the lethal effects of a single intraperitoneal dose of 3.0 mg/kg of mercuric chloride an equimolar amount of *dl*-penicillamine does not. An equimolar amount of *d*-penicillamine, however, does give a significant amount of protection. In addition, *d*-penicillamine does not inhibit E. coli, as the *l*-isomer does. Therefore *d*-penicillamine not only is a more effective agent than the other isomers in treating heavy-metal poisoning but is safer as well. It may find use as an oral agent in the treatment of such poisonings.

Toxicological Studies on Bis(Tri-n-Butyl Tin) Oxide. J. R. Elsea* and O. E. Paynter. A.M.A. Arch. Indust. Health 18:214 (Sept.) 1958. (*Hazelton Laboratories, Falls Church, Va.)

The acute oral LD_{50} of bis(tri-n-butyl tin) oxide $[(H_9C_4)_3Sn]_2O$ for male albino rats is reported as 194 mg/kg when administered in an oil medium and 148 mg/kg in an aqueous medium. When fed to male albino rats at levels of 32, 100, and 320 ppm in the diet for 30 days, there was growth suppression in all test animals which increased in severity with increased feeding levels. There were no deaths in the 32 and 100 ppm groups, and 6/10 deaths in the 320 ppm group. Except for an almost complete lack of fat stores in the body of animals which died, no characteristic gross pathologic change was noted at autopsy. The acute dermal LD_{50} for albino rabbits is given as approximately 11.7 gm/kg, a single application of the undiluted material producing a moderate degree of dermal irritation, with gross signs of systemic toxicity

from skin absorption. Five daily applications of a newsprint-type paper containing 8 ppm of this compound to the skin of rabbits produced no gross evidence of dermal irritation or systemic toxicity. This compound is finding wide use in the paper industry for the control of slime in water systems and for the general control of bacteria and fungi in allied industrial applications, such as wood preservation.

Relative Toxicity of Seven Halogenated Hydrocarbons. G. L. Plaa, Elizabeth A. Evans, and C. H. Hine. J. Pharmacol. & Exper. Therap. 123:224 (July) 1958.

Hepatotoxicity of various agents may be evaluated simply and rapidly by observing the prolongation of pentobarbital sleeping time which accompanies liver damage. After determining the normal sleeping time in mice with 45 mg/kg of pentobarbital, the hydrocarbons to be tested were injected subcutaneously diluted with peanut oil and sleeping time determined 24 hours later. In 72% of the observations, prolonged sleeping time, gross lesions, and microscopic evidence of liver damage were seen together. In 85%, the sleeping time was consistent with the microscopic findings, and in 95% it was consistent with either the gross or the microscopic findings, or both. Thus the data can be resolved into a standard dose-response curve, permitting an estimate of the ED_{50} for production of hepatic damage. Of the compounds tested, hepatotoxic potency, in increasing order, was 1,1,1-trichloroethane; tetrachloroethylene; trichloroethylene; sym.-tetrachloroethane; 1,1,2-trichloroethane; chloroform; and carbon tetrachloride. Interestingly, there is no correlation between dose causing liver damage and dose causing death. These data on hepatotoxicity should not be used to predict industrial hazard without considering other factors about a compound, such as LD_{50}, vapor pressure, partition distribution between blood and tissues, and rate and route of absorption.

Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of Some Aliphatic and Aromatic Thiols (Mercaptans). E. J. Fairchild* and H. E. Stokinger. Am. Indust. Hyg. A. J. 19:171 (June) 1958. (*Occupational Health Program, Bureau of State Services, Public Health Service, U. S. Department of Health, Education and Welfare, 1014 Broadway, Cincinnati.)

According to a classification of toxicity based on results from all routes of administration in mice, rats, and rabbits, benzene- and methyl heptanethiol and highly toxic. Alpha-toluenethiol is moderately toxic; ethane-, propane-, butane-, and hexanethiol, slightly toxic; and 2-methyl-1-propane- and 2-methyl-2-propanethiol, practically nontoxic. Except for methyl heptanethiol, which is a powerful central nervous system stimulant in relatively small doses, the thiols in acute doses cause central depression and respiratory paralysis, with death from respiratory failure. Despite the analeptic action of methyl heptanethiol, the end-result of acute poisoning is the same as with other thiols: central depression and death from respiratory failure. A distinction is made between toxicity rating and hazard from thiols. Ethane-, butane-, hexane-, and benzenethiol are rated moderately to very severe hazards because of their high volatility and suspected role (demonstrated for benzenethiol) in activating latent pulmonary infection. Methyl heptanethiol is considered severely hazardous because of its high toxicity. Personnel handling thiols should be warned against breathing contaminated atmosphere for prolonged periods, or benzene- or methyl heptanethiol for even short periods. In addition, the last-named compounds are easily absorbed through the skin. Eye splashes should be guarded against, since relatively small amounts of all but hexanethiol produce moderate irritation of the conjuntivae and benzenethiol causes severe corneal damage with resultant visual handicap. Emergency treatment of general thiol intoxication should consist of supportive measures.

Acute Toxicity of Red Fuming Nitric Acid-Hydrofluoric Acid Vapor Mixture. E. A. Pfitzer,* P. P. Yevich, E. A. Greene, and K. H. Jacobson. A.M.A. Arch. Indust. Health 18:218 (Sept.) 1958. (*Department of Occupational Health, University of Pittsburgh.)

In single four-hour vapor exposure tests, the acute toxicity for rats and mice of red fuming nitric acid vapor was not significantly altered by the addition of 0.1% or 0.5% hydrofluoric acid. The LC_{50} values for rats were 119 ppm of NO_2 for red fuming nitric acid (RFNA) and 113 ppm for RFNA/0.1% HF and 112 ppm for RFNA/0.5% HF; for mice the LC_{50} value was approximately 170 ppm of NO_2 for all groups. Pulmonary edema was the prominent feature seen at autopsy. Tests on 12 human volunteers indicated that the odor of vapor from the RFNA/0.1% HF mixture is similar to that of NO_2, the median level of detection being 0.8 ppm — the same as for NO_2. The addition of small amounts of HF to RFNA reduces the storage problems of RFNA.

Effect of Acute Ethanol Intoxication on Liver and Plasma Lipid Fractions of the Rat. N. R. DiLuzio.* Am. J. Physiol. 194: 457 (Sept.) 1958. (*Department of Biological Chemistry, Harvard Medical School, Boston.)

Eight and sixteen hours after administration of a mildly intoxicating dose of ethanol to rats, a significant increase in liver weight was noted over that in rats given saline or isocaloric amounts of glucose. In addition, in the ethanol-treated rats, liver triglyceride concentration was elevated 250% and 160% over that in glucose-treated animals. The increase in liver triglyceride at 16 hours after ethanol intoxication is comparable to liver lipid values of rats maintained on a high-fat, low-protein, choline-deficient diet for 9 days. However the choline-deficient group also showed a 29% reduction in

liver phospholipid concentration. The fact that a marked elevation in liver triglyceride can be rapidly produced after a single administration of a mildly intoxicating amount of alcohol to a rat on an adequate diet suggests that nutritional deficiencies such as dietary lack of choline and its precursors, superimposed on the basic effect of ethanol, would result in intensification of fatty infiltration of the liver.

Reparative Surgery

Joseph M. Dziob, M.D.

Methods and Results in the Treatment of 2,580 Painful Shoulders, with Special Reference to Calcific Tendinitis and the Frozen Shoulder. Paul H. Harmon.* Am. J. Surg., 95:527, 1958. (*6305 Yucca St., Los Angeles.)

The author reports upon a personal experience with 609 cases of calcified tendinitis of the rotator cuff and 803 cases of the so-called "frozen" shoulder from a total of 2,580 painful shoulders seen during the past seventeen years. Excellent results were obtained within 14 days in 78.9% of 314 shoulders with calcium deposits treated by injection of local anesthetics and/or cortone drug suspension needling. There was no difference in the recovery rate in those receiving the cortone drug suspensions, but the impression was that there was less pain and less need for sedation with the use of cortone drugs. In follow-up studies of six months to two years, maintenance of recovery was demonstrated in 81.1% of the cases. Surgical excision produced the quickest recovery in cases with acute and hyperacute large and medium calcium deposits. Surgical excision is also indicated in cases of medium and large granular deposits giving very chronic symptoms. Roentgen ray treatments had no demonstrable effect in calcific tendinitis not explainable by rest and/or exercise and sedation. In cases of the frozen shoulder syndrome, exercises and manipulations are effective in restoring motion, especially in the "snapping response" to gentle manipulation. Immediately beneficial results with motion maintenance were observed in 90% of cases in which there was sudden snap and release to full passive range.

Fractures of the Os Calcis. W. R. N. Lindsay* and E. P. Dewar. Am. J. Surg. 95:555, 1958. (*Division of Orthopaedics, Toronto General Hospital, Toronto, Canada.)

A detailed follow-up study with an average of eight years since injury was made on 147 cases of os calcis fracture, all of which showed involvement of the subastragaloid joint. Various methods of treatment had been employed, including (1) active motion, (2) plaster immobilization, (3) manipulation or traction reduction, and (4) surgical arthrodesis. A conservative form of treatment gave good results in 76% of cases, and surgical arthrodesis produced good results in 60%. When closed reduction was employed, 75% had good results, but 81% had good results when no reduction was employed.

Pain is the major disabling symptom and is localized to the lateral malleolus, heel, calcaneocuboid and taloscaphoid joints, and the ankle. Of these, malleolar and heel pain are the chief sources of disability, and the pain is not relieved by subastragaloid arthrodesis. Pain-free patients were found to have flattened arches, thickened heels, and movement in the subastragoloid joint, indicating that fibrous ankylosis is not necessary to relieve pain.

The authors conclude that there is need for investigation of the soft tissues for the etiology of residual pain in os calcis fractures.

Recent Evaluation of the Treatment of Tetanus. Charles L. Miller* and V. K. Stoelting. J.A.M.A. 168:393. (*Creighton University, Omaha.)

The plan for managing the patient with tetanus at the Indiana Medical Center has as its objective the prevention of asphyxia by controlling the muscle spasms and the provision of good supportive care. Sedation is given under the supervision of an anesthesiologist, and the short-acting barbiturates are preferred—intramuscularly every two, three or four hours. Barbiturates do not produce flaccidity, but convulsions resulting from external stimuli can be prevented. In addition, promethazine hydrochloride (Phenergan) is given every six hours intramuscularly to lessen anxiety of the lucid patient. After the initial sedation, tracheostomy is performed under local anesthesia. A supportive program is then started. The site of infection is debrided and tetanus antitoxin injected locally into the wound. The patient also receives 50,000 to 100,000 units of antitoxin intravenously to neutralize the free toxin. Antibiotics are administered to diminish the incidence of pulmonary complications. The patient is kept in a quiet, darkened room. Seventeen patients with tetanus were treated, with a mortality rate of 17%, compared with the national average of 50%.

Dermal Overgrafting of the Leg. George V. Webster,* Rex A. Peterson, and Harold L. Stein. J. Bone & Joint Surg. 40-A:796, 1958. (*Department of Surgery [Plastic] University of California at Los Angeles School of Medicine.)

The usual treatment of scarred and fragile areas on the lower extremity, especially when overlying bone, is the application of a pedicle graft or the excision of the ulcer with split-skin-graft coverage. In older and debilitated patients pedicle graft is not applicable, and in some instances, following excision of the ulcer and split-graft, minor areas of necrosis of the graft result in healing by scar, which is frequently no better than the scar replaced by the skin graft originally. The authors selected 10 such cases for treatment by dermal overgrafting. The ulcerated area and surrounding scar tissue was surgically abraded with wet-or-dry 100-D grit sandpaper until the epidermis was removed and an actively bleeding surface encountered. A split-skin-graft, 0.015 in. thick, was then attached to the

entire abraded area by a number of peripheral sutures and a compression dressing maintained for 10 to 12 days. Grafts uniformly healed well.

By this technique benefit is derived from the addition of thick dermis with its content of elastic fibers acting as a cushion. The method is particularly applicable to augment the healing of a previous graft on an ulcer which has only partially taken or when reulceration occurs within a skin graft. In one instance, as many as three separate grafts were piled on top of one another in three separate operations.

Orthopedic Surgery

Owen E. Miller, M.D.

Surgical Treatment of Trigger Finger by a Subcutaneous Method. Jean Lorthioir.* J. Bone & Joint Surg. 40-A:793-796 (July) 1958. (*Clinique chirurgicale de l' hôpital universitaire, St. Pierre, Brussels, Belgium.)

Trigger finger is characterized by inability to flex and extend the finger evenly. It is due to the presence of an enlargement in the tendon in front of the opening of the proximal annular ligament or osteofibrous canal of the finger. The proximal extremity of the osteofibrous canal ends about 1 cm. proximal to the metacarpophalangeal articulation, and its origin is located at the level of the distal palmar flexion crease for the last three digits and at the level of the proximal crease for the thumb and index finger. No nerves or vessels lie between the osteofibrous canal and the skin. The instrument used to correct trigger finger is a fine tenotome with a blade 1 mm. wide and 1 cm. long. The procedure is performed under procaine (Novocain) anesthesia. The skin is pierced with the tenotome, the point of which is directed toward the base of the opening of the osteofibrous canal. One should be able to feel the fibers of the tendon sliding under the blade. The blade is then passed under the edge of the canal. Then, working from below up, a cut a few millimeters in length is made. The incision should be made exactly over the midline of the metacarpal. The author reports doing this operation in 52 cases, with good results.

Preliminary Report of the Committee on Fractures and Traumatic Surgery on the Use of a Prosthesis in the Treatment of Fresh Fractures of the Neck of the Femur. Fred C. Reynolds.* J. Bone & Joint Surg. 40-A:877-886 (July) 1958. (*St. Louis.)

Reynolds study of the use of prosthesis for fresh fractures of the neck of the femur in 163 cases performed by members of the Committee. In 19 (12%), the results were excellent; in 44 (29%), results were good, and in 37 (22%) the results were fair. Thus 100 of the 163 could be considered to have a satisfactory result. Two principal approaches were used: the anterior (Smith-Peterson) and the posterior (Gibson). Hospitalization was shorter with the anterior approach. The rate of complications was similar, except that a higher death rate in the first 30 days occurred in the posterior group. In the posterior group there was a higher rate of satisfactoy results. In general, the two groups compare well. It appeared as though the long-stem metal type prosthesis gave the best results. The insertion of a prosthesis was not much more hazardous, nor the postoperative complications much greater, than was the case with internal fixation. The Committee felt that the method should not be used in any patient in whom there was a reasonable chance of obtaining union, provided that the general condition of the patient was such that a reconstructive procedure could be carried out if internal fixation should fail. The indications for the replacement prosthesis in fresh femoral fractures are the following: (1) when an old patient is a relatively poor risk and it seems likely that only one surgical procedure will be possible; (2) when early ambulation is essential and the condition of the patient makes the use of a walker or crutches unlikely; (3) when a patient has Parkinson's disease or spastic paralysis, and (4) when a satisfactory result cannot be obtained even by open operation.

Dupuytren's Contracture. Robert D. Larsen* and Joseph L. Posch. J. Bone & Joint Surg. 40-A:773-792 (July) 1958. (*Department of Surgery, Wayne State University College of Medicine, Detroit.)

Dupuytren's contracture occurs in about 1% to 2% of the population, usually in the older age groups. It is more common in the right hand, and the ulnar side is most often involved. It is about eight times as frequent in men as in women. The disease begins with a painless nodule usually at the base of the ring finger in the distal palmar crease. With progression more nodules occur, with the development of contracted longitudinal bands which draw the metacarpophalangeal and proximal interphalangeal joints into flexion.

Recent authors have not felt that trauma was a factor in etiology. The disease is more common in patients who do not perform manual labor. Heredity is involved in some cases. There are four major concepts concerning the histopathology of the contracture: (1) benign hyperplasia of fibrous tissue arising in the palmar aponeurosis; (2) inflammatory changes arising in the interstitial connective tissue of the palm and secondarily involving the aponeurosis; (3) benign neoplasm—fibroma; (4) cellular hyperplasia in response to rupture of the collagenous fibers of the palmar aponeurosis. On the basis of histopathologic studies of 61 specimens, the authors noted in 9 the presence of iron pigment. They felt that the iron pigment suggested old hemorrhage associated with the actively proliferating fibrous tissue. The evidence of hemorrhage would suggest trauma as a cause of hemorrhage. They were not able definitely to include or exclude trauma as a factor in the pathogenesis and felt that further work was necessary in the field. Those experienced in treatment of the contracture agree that the most effective treatment is surgical. There are three recognized types of operation: fasciotomy or simple division of the con-

tracted bands, which the authors recommend as an open rather than as a blind procedure; excision of the diseased tissue with a varying margin of normal tissue; finally, the radical operation in which all recognizable palmar fascia with the vertical septa which pass to the preosseous fascia and the pretendinous bands extending into the fingers is excised. When the contracture has existed so long that joint changes have occurred, perfect results are difficult to attain.

Observation of the patient is worth while. If the contracture is in an early stage, static surgery is not necessary. If the lesion is rapidly progressive surgery is recommended. A hand with marked arthritic changes does not tolerate extensive surgery well; neither does a broad hand with stubby fingers and some stiffness, as is seen in laborers. The authors performed total excision of the palmar fascia in 64 patients; partial fasciectomy in 20; definitive fasciotomy in 2; preliminary fasciotomy in 3. In two patients excision of a finger nodule was done. In 8, skin grafts were necessary. Fasciotomy was limited to those patients in whom more extensive procedures were contraindicated, or it was done as a preliminary to one of the more radical procedures. With the partial fasciectomy 18 excellent results were attained, with one having prolonged hand stiffness and another persistent finger flexion. Radical excision of the palmar fascia was used in 64 patients. In the series, 89 hands were operated upon in 74 patients. Fifty-two hands had an excellent result with extension normal or near normal. Twenty-two hands were good, classified so because of slight residual stiffness. Five had a fair result, and five a poor result.

Dermatology

Raymond R. Suskind, M.D.

The Penetration of an Anticholinesterase Agent (Sarin) into Skin. I. H. Blank,* R. D. Griesemer, and E. Gould. I. Rate of Penetration into Excised Human Skin, J. Invest, Dermat. 29:299-309, 1957; II. Autoradiographic Studies, ibid. 30:187-191, 1958. (*Dermatological Research Laboratories, Massachusetts General Hospital, Boston 14)

In any study of the percutaneous absorption of a new material one is frequently confronted with difficulties in determining experimentally the answers to several key questions: (1) does it penetrate intact skin; (2) if it does, at what rate does it penetrate; (3) what is the influence of such factors as amount applied, exposure time, temperature, trauma, and physical state of material, and (4) by what route does the material get through? These two reports constitute the results of part of a systematic study to determine the absorption properties of Sarin (isopropylmethylphosphonofluoride), an anticholinesterase agent. The authors have devised a very ingenious diffusion technic in which freshly excised autopsy skin is employed and by which the rate of penetration ($m\mu$ M/cm^2/hr) into the dermis may be measured. Their data demonstrate that the rate is independent of the amount applied and duration of exposure but increases twofold for a 10°C rise in temperature. The rate increases markedly when the cutaneous barrier at the base of the corneal layer is punctured or removed by successive stripping with adhesive plaster. The rate of penetration when the skin is exposed to the Sarin vapor is lower than when liquid Sarin is placed on the skin.

The results of the autoradiographic studies which were carried out jointly with the quantitative researches are just as intriguing. The route of penetration appears to be primarily transepidermal. The autoradiograms of skin to which Sarin was applied in the living animal were the same as those in which Sarin was applied to excised skin. They also demonstrated that intactness of the barrier layer is important in limiting penetration.

This is a most significant work not only because its systematic approach provides information about the specific penetration properties of a given chemical substance, but because the authors' observations provide new insight into the fundamentals of percutaneous absorption and help clarify at least one misconception now current regarding pathways of penetration.

The Irritating and Sensitizing Capacity of Epoxy Resins. W. A. Lea, Jr.,* W. D. Block, and H. H. Cornish. A. M. A. Arch. Dermat. 78:304-308, 1958. (*Department of Dermatology, University Hospital, University of Michigan, Ann Arbor, Mich.)

The cutaneous problems arising from exposures to less-than-cured epoxy resins as well as a variety of curing agents have been extensively described. The present report is concerned apparently with the appraisal of irritation and sensitization capacity of one monomer or uncured resin, a resin modifier, and four different curing agents. Twenty-five subjects were exposed to each material by a standard Schwartz "prophetic" patch test. Threshold concentrations for irritancy were established by testing with a range of concentrations from 100 per cent to 1.25 per cent. Fortunately the authors found it easy to distinguish the gold from the dross, because all but one material had substantial irritation and sensitization reaction rates. They believe that one amine curing agent, XH 173-50, had a low capacity for irritation and produced no sensitizing reactions. The reviewer is curious to know whether the authors would be willing to consider what the likelihood of reactions in the general population might be on the basis of observations in 25 samples. The answer is found in the published table of Henderson and Riley (Henderson, C. R. and Riley, E. C.: Certain Statistical Considerations in Patch Testing, *J. Invest. Dermat.* 6:227, 1945). The upper limit of reaction rate estimated for the population when no reactions are elicited in a sample of 25 would be about 11.7 per cent.

The reviewer has no objection whatsoever to making preliminary observations in this way. Such

observations are extremely useful to the industrial sponsor who wants to know whether it is financially worth while to invest in more extensive appraisals prior to marketing. He does find fault with the investigators' desire to publish such results, since the crucial observations were made in an inadequate sample and these observations are subject to misinterpretation.

Lesions of the Skin in Process Workers Caused by Contact with Butyl Tin Compounds. W. H. Lyle.* Brit. J. Indust. Med. 15:193-196, 1958. (*Pure Chemical Ltd., Liverpool, England)

The compounds with which the authors are chiefly concerned are used as "stabilizers" in plastics and polymerizers in silicone manufacture. These are very corrosive materials even when allowed to remain on the skin for a few minutes. The lesions are essentially of two types: (1) acute localized burns caused by accidental splashes and (2) subacute irritation of large areas, such as trunk and thighs, caused by contamination of clothing by vapors or spilling. Both are painless and heal without treatment. Neither eruption results in appreciable lost time. Allergic sensitization of the skin by exposure to butyl tin compounds has not been observed nor was there evidence of systemic intoxication in the persons observed. Effective prophylactic measures are described.

Skin Manifestations of Organic Phosphate Insecticide Poisoning. T. R. Funt.* A. M. A. Arch. Dermat. 78:82-84, 1958. (*Division of Dermatology, Department of Medicine, University of Miami School of Medicine, Coral Gables, Fla.)

Funt describes the case of a 25-year-old fireman who was engaged in parathion spraying during his off hours. His major dermatologic complaint was periodic profuse sweating of the arms and back associated with mild pruritus. Two weeks prior to the initial examination he and two of his spraying associates were hospitalized for nausea and vomiting. The dermatologist observed areas of localized excessive sweating on the drosa of the arms and the scapulae, extensive cutis anserina (goose flesh) over the posterior thorax and upper arms, and paradoxical dilatation of the pupils. Two weeks after the patient discontinued handling parathion the hyperhidrosis subsided completely; the goose flesh involuted completely after four weeks.

Lichenoid Eruptions Following Contact Dermatitis. W. R. Buckley.* A. M. A. Arch. Dermat. 78: 454-457, 1958. (*Medical Department, Eastman Kodak Company, Rochester, N.Y.)

The clinical problems in the film manufacturing and chemical industry have been studied carefully by Buckley for several years. In this report he is specifically concerned with the allergic eruptions observed in persons exposed to aromatic amines of the substituted paraphenylenediamine type. The striking features are the clinical and histopathological similarity of the resolving process to lichen planus. Significant epidemiologic and patch test data are presented. The article is illustrated with beautiful color prints of the gross and microscopic findings.

Mental Health

Graham C. Taylor, M.D.

A Proposed Technique for Assessing Adjustment at Work. John G. Hipps.* Indust. Med. 27:520-523 (Oct.) 1958. (*Bettis Plant, Westinghouse Electric Corporation, Pittsburgh.)

The adjustment of the individual to life is related to a state of mental health and there are major eras of adjustment in (*a*) the home, (*b*) the community, and (*c*) the job. Hipps attempts an assessment of the person's adjustment as regards his job which may indicate something about his total adjustment.

The author has developed a technique which consists of a daily assessment of each employee by his immediate supervisor using certain carefully selected criteria which must meet the standards of being quantitative or quantifiable, applicable to a large group, and capable of being used by the plant supervisors. He selected three criteria: attendance, productivity, and behavior. There are components listed under each of these headings. An employee weekly assessment record was drawn up, and there was a supplement which has to do primarily with data concerning dispensary visits. The individual employee is assessed one week at a time. A field study was undertaken in the plant and was applied by 20 supervisors to 175 workers.

The author concludes that this technique is a usable one, and it takes roughly about 1.3 minutes per man per day of the supervisor's time. He furthermore found out that 75% of the supervisors were willing to continue with the technique. It should be noted that at this stage of the development of the technique there is no particular information gathered concerning the precise nature of the reasons for dispensary visits or absence from work; this presumably will follow later.

The Impact of Emotions on Production and Safety. R. B. O'Connor.* Menninger Quart., Sept. 1958. (*Medical Director, United States Steel Corporation, Pittsburgh.)

This article, based upon a presentation given by the author at a seminar for industrial physicians at the Menninger Foundation in March, 1958, describes four employees who came to the medical department requesting a change of job. The author points out that "there is a direct relation between emotions and safety at work. Preoccupation with a personal problem takes one's mind away from the task at hand and leads to the unsafe acts that produce the so-called 'personal causes' of accidents."

From the material described, it is concluded that (1) there is a direct impact of emotions on production; (2) there is a relationship between emo-

tions and safety on the job—"when a man's thoughts are on an emotional problem instead of on his work, he is a good candidate for an accident"; (3) nurses and physicians should play an important role in counselling and guiding employees with emotional problems.

Motivation of the Patient in Rehabilitation. Leonard E. Himler.* Indust. Med. 27:439 (Sept.) 1958. (*School of Public Health, University of Michigan, Ann Arbor.)

Dr. Himler, who has contributed many interesting articles to the literature of Industrial Psychiatry this time has an article dealing with the importance of *motivation* of the patient in rehabilitation. He points out that the patient's attitude towards his disability may be out of proportion to the actual injury. The need of the worker to be aware of his emotional reactions and how they may affect his rehabilitation is stressed. The significance of the patient's body image—what he thinks of his body in relation to others is also a key factor.

There are sections on forces that aid rehabilitation, factors that impede rehabilitation, and implications for treatments.

Communication Only Seems Simple. Fred Dowling.* Personnel. J., Oct., 1958, pp. 177-179. (*Faculty Associate, Labor and Industrial Relations Center, Michigan State University, East Lansing.)

This brief article highlights the fact that communication is indeed a complex process which can be diagrammed as "sending—encoding—message—decoding—receiver." The author analyzes the difficulty which may be involved at each one of these stages. Finally, the need for feedback is stressed.

How to Find the Best in Every Man. Bernard Haldane. Personnel, Sept., Oct., 1958, pp. 9-17.

This article contains an interesting quotation from C. H. Greenwalt, President of E. I. DuPont de Nemours & Co.: "Not only the organization, but society itself suffers when people are allowed to sacrifice identity for the damp laundry of mediocrity." Haldane discusses current techniques of selection and appraisal. He believes that in evaluating an employee we should try to find out from him what is his best recent performance in the past, and in this way we will understand him better and help him understand himself. He also believes that we should concentrate on the individual and not rely on mass methods.

What About the Future of Personnel Administration? Charles A. Myers.* Personnel Admin., Sept.-Oct., 1958, pp. 5-12. (*Professor of Industrial Relations, Division of the Industrial Relations Section in the Department of Economics and Social Science, Massachusetts Institute of Technology.)

The author of this article is also co-author of the book "Personnel Administration, the third edition of which appeared in 1956.

Since medical departments work closely with personnel administration, this article will be of interest to industrial physicians because it deals with current criticism of personnel administration and attempts to suggest some general directions toward which personnel administration might move in the future. The author refers to the criticism that personnel administration sometimes attempts to avoid the genuine acceptance of unions and refers also to the trend toward conformity. He suggests a reemphasis of a basic philosophy based on the belief in the dignity of the individual and the avoidance of being technique-minded.

A New Look at Management Development. Leland P. Bradford.* Advanced Management, Oct. 1958, pp. 9-13. (*Director, National Training Laboratories, Washington, D.C.)

The industrial physician should be familiar with current thinking as regards management development. The trend is away from "the short package course attempting to tell the leader what to do to others, to more effective long range development programs attempting to help the leader understand and improve himself in basic qualities of leadership and membership." The trainee will require support on the job as he applies to his job skills that which he has learned in his training experience.

A description is given of the methods used in training people in group skills and in leadership skills, based upon generelly accepted procedures of group dynamics.

Clinical Toxicology

Lee A. Miller, M.D., I.M.D.

Silo-Fillers Disease: Report of a Case. J. Gailitis,* L. E. Burns, and J. B. Nally. New England J. Med. 258:543-544 (March 13) 1958. (*Assistant in Medicine, Newport Hospital, Newport, R.I.)

Silo-filler's disease is a syndrome that is produced by the inhalation of the oxides of nitrogen (nitrogen dioxide and nitrogen tetroxide) that may be evolved under certain conditions from ensilage. The severity of the clinical picture is dependent upon the concentration of the oxides of nitrogen in the atmosphere and the duration of the exposure. A typical chemical reaction consisting of bronchitis, bronchiolitis, and delayed pulmonary edema may result. The authors describe a case in which the patient's condition deteriorated while he was being treated with bronchodilators and the administration of oxygen. Because of this, adrenocortical steroid therapy (prednisone, 20 mg. every six hours) was administered. Within 24 hours all signs of respiratory distress had disappeared, and the previous physical signs in the lungs had vanished. Withdrawal of the maintenance dose several weeks later was followed by a relapse which necessitated the resumption of treatment. The medication was withdrawn successfully three months after the patient was discharged from the hospital. Ten months after his illness, the patient was well and had returned to work on his farm.

Parathion Residues as a Cause of Poisoning in Crop Workers. G. E. Quinby* and A. B. Lemmon. J.A.M.A. 166:740-746 (Feb. 15) 1958. (*USPHS Communicable Disease Center, Wenatchee, Wash.)

Although it has been recognized that a potential hazard to workmen exists from contact with parathion residues, it has not received much attention. After spraying, the amount of residue decreases rapidly; however, it has been demonstrated that significant quantities of residue may remain for weeks. Because of this, workers engaged in harvesting, thinning, cultivating, and irrigating crops, may, under certain conditions, become ill. Data on parathion poisoning in over 70 crop workers exposed to residues and the circumstances associated with the exposures at 11 locations are presented. In one instance, poisoning occurred in 16 workers 33 days after the vineyard was sprayed. All the cases described were relatively mild, and it is believed that absorption occurred principally through the skin. The importance of various weather conditions with relation to the degree of contamination is discussed. In view of the circumstances surrounding these cases of intoxication, the authors believe that regulations and recommendations which have been promulgated to prevent the occurrence of such episodes not only are justified in purpose but probably need review, modification, and improved enforcement if such incidents are to be prevented.

Anticholinesterase Activity: Recognition and Detection in the Field and Hospital. H. H. Golz.* A.M.A. Arch. Indust. Health 18:138-141 (Aug.) 1958. (*Associate Medical Director, American Cyanamid Company, 30 Rockefeller Plaza, New York.)

The need for a suitable test for the measurement of blood cholinesterase activity under field conditions is cited. The ideal field test should be accurate, simple, quick, and applicable to large numbers of personnel. In each of the various manometric, colorimetric, and electrometric methods, a measured amount of acetylcholine is incubated with a measured amount of blood or tissue and the extent to which hydrolysis occurs in the following reaction is determined:

$$\underset{\text{Acetylcholine}}{(CH_3)_3\,N(OH)CH_2CH_2OCOCH_3} + HOH \xrightarrow{\text{Water (Cholinesterase)}} \underset{\text{Choline}}{(CH_3)_3\,N(OH)CH_2CH_2OH} + \underset{\text{Acetic acid}}{CH_3COOH}$$

Most methods currently in use are not satisfactory for routine examination of field workers because they involve relatively complex analytic procedures.

A modification of a screening test developed by Limperos and Ranta is described. A 0.02 ml. sample of whole blood is introduced into a mixture of acetylcholine and bromthymol blue and incubated in the axilla of the test subject for 20 minutes. The final color of the solution is compared with a standard supplied with the kit. The author emphasizes that the test is suitable for mass screening programs only because it is carried out with whole blood and, in addition, an error in accuracy of ±25% may result. Persons who have cholinesterase inhibition as demonstrated by this method should not be permitted to have further exposure to phosphate esters until more accurate cholinesterase determinations are made. The preparation of samples of blood for transit to a laboratory for more precise determinations is discussed.

Roentgen Resurvey of Cement Workers. A. O. Sander,* A.M.A. Arch. Indust. Health 17:96-103 (Feb.) 1958. (*710 N. Plankinton Ave., Milwaukee 3.)

Chest x-ray films were obtained on 195 employees who had had continual exposure to cement dust since previous studies were made in 1934 and 1937. One hundred twenty (61.5%) had films that were either "within normal limits" or had only slightly exaggerated linear markings consistent with age. Sixty-eight (35%) had films that showed "moderate linear exaggerations," while six (3%) had films that revealed "marked linear exaggeration with ill-defined micronodular shadows." One worker's film showed a definite micronodular pattern with normal root shadows. Comparison with previous films showed an increase in lung markings in 13 cases; it is pointed out, however, that there are many causes other than dust retention that may produce similar changes. Moderate linear exaggeration was more prevalent in persons who had exposures to "raw" and "mixed" cement dusts than in those exposed to "finished" cement dusts. Micronodulation or marked linear exaggeration was not found in employees who had over 30 years' exposure to "finished" cement dusts. No case of active tuberculosis was found which suggested that the inhalation of "raw," "mixed," or "finished" cement dusts do not predispose to tuberculosis. A table is presented in which the type, severity, and years of experience are correlated with the roentgen findings.

The author concludes that long-term exposure to high concentrations of "raw" and "mixed" cement dusts may result in marked linear exaggeration and ill-defined micronodulation on the x-ray films. He suggests that these changes may be due to the retention of some of the dust in the lymphatics of the lungs. With "finished" cement dust, however, it is indicated that the dust is largely absorbed and that there is little or no retention and no resulting fibrosis.

Internal Medicine

Shermer Stradley, Jr., M.D.

Tobacco Amblyopia: A Clinical Manifestation of Vitamin B^{12} Deficiency. J. M. Heaton.* Lancet 2:286 (Aug. 9) 1958. (*Registrar, Bristol Eye Hospital.)

Tobacco amblyopia, according to the authors, usually affects persons who smoke strong pipe tobacco with cigars and cigarettes seldom being responsible. The retina and the optic nerve are unduly sensitive to tobacco even with a mild vitamin

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B_{12} deficiency. Alcohol apparently increases this sensitivity.

The criteria upon which the diagnosis of tobacco amblyopia is based is clearly outlined. That tobacco amblyopia occurs in persons with pernicious anemia is evidenced by histamine-fast achlorhydria and megaloblastic bone marrow found in some patients. It is suggested that the retrobulbar neuritis of pernicious anemia and tobacco amblyopia may be one and the same condition.

Tobacco amblyopia also occurs in persons without the findings diagnostic of pernicious anemia, but with the clinical manifestations of vitamin B_{12} deficiency such as glossitis, peripheral neuropathy and posterior column involvement.

Serum vitamin B_{12} levels in tobacco amblyopia ranged from 15 to 350 micromicrograms/ml, the mean level being 218 micromicrograms/ml, while in the controls, the mean was 538 micromicrograms/ml. Therapy with cyanocobalamin parenterally, improved visual acuity and completely reversed the visual field findings.

Allergic Reactions to Tranquillizing Drugs. Leo E. Hollister.* Ann. Int. Med. (July) 1958. (*Chief, Medical Service, Veterans Administration Hospital, Palo Alto, Calif.)

Three classes of tranquillizing drugs and their reactions are discussed: (1) phenothiazine derivatives, notably chlorpromazine, (2) the Rauwolfia alkaloids, notably resperine and (3) the substituted propanediols or butanediols, notably meprobamate.

Reactions to phenothiazine derivatives are: agranulocytosis, the most serious complication; jaundice, a more frequent complication than agranulocytosis, but considered less serious; and three types of dermatitis. The skin's reactions are:

(1) Generalized eruptions of maculopapular, urticarial, petechial, edematous and bullous lesions, all on the basis of systemic sensitization.

(2) Contact dermatitis, usually on the hands, is usually associated with a positive patch test.

(3) Photosensitive dermatitis, occurring on exposed parts and resembling sunburn.

Rauwolfia alkaloids have caused so few reactions that their allergenicity is questioned. Allergic reactions are the most serious complication of meprobamate therapy, usually manifested by chills, fever, vascular collapse gastrointestinal symptoms, and skin rash occurring within hours of the first or second dose.

Rheumatoid Spondylitis: Manifestations and Management. Aaron M. Lefkovits* and J. R. Thomas. Annals Int. Med. (July) 1958. (*Chief, Section on General Medicine and Rheumatology, Veterans Administration Medical Teaching Group Hospital, Memphis 15.)

This article emphasizes the need for, and the difficulties of, the early diagnosis of rheumatoid spondylitis. Early valuable clinical signs such as the insidious mode of onset and the pain-free periods of variable duration are discussed. Emphasis is placed on (1) the aching and stiffness of any part of the lumbodorsal spine awakening the patient during the night, necessitating his getting up and walking in order to "limber up" to obtain relief; (2) repetition of this "limbering up" process two or three times nightly; (3) stiffness and aching of the lumbodorsal spine on awakening in the morning, but "limbering up" with activity; and (4) the reaction of the patient to specific orthopedic test maneuvers.

The results of various laboratory procedures are described, as are the difficulties met in the interpretation of radiographs. A special inclined roentgen view of the sacroiliac joints proved helpful, since all 267 patients studied showed evidence of disease of this area.

Management of the patient is discussed in terms of physical therapy, proper posture, and exercises, and special therapy for those patients with osteoporosis is outlined.

Diagnosis and Clinical Management of Functioning Carcinoids. William G. Sauer,* William H. Dearing and Eunice V. Flock. J.A.M.A. 168:139 (Sept. 13) 1958. (*Section of Medicine, Mayo Clinic and Mayo Foundation, Rochester, Minn.)

It was originally thought that carcinoids were benign lesions. Recently it was realized that they do metastasize. They secrete serotonin, which affects the vessels of the skin, the smooth muscle of the gastrointestinal tract and bronchi, and the valves of the heart. The excess serotonin is responsible for the cardinal symptoms, which include cutaneous flushing, diarrhea, episodes of asthma, liver enlargement, dependent edema, and cardiac findings compatible with pulmonic stenosis or tricuspid insufficiency or both. Not all the clinical features need be present simultaneously; indeed, functioning carcinoids may be present and be asymptomatic. To confirm the diagnosis, abnormal amounts of 5-hydroxy=3-indoleacetic acid should be demonstrated in the urine by a simple qualitative test. Bananas should be excluded from the diet prior to the urine test, as they may cause an increase in 5-hydroxy-3-indoleacetic acid.

The sites of the primary lesion in the 12 cases reported were: 7 in the small intestine, 1 in the cardia of the stomach, 1 in an ovarian teratoma, and, of most interest, 3 in the lung, apparently the carcinoid type of bronchial adenoma.

The treatment of choice is surgical excision of all or as much of the tumor as possible.

Noise and Hearing

H. O. Parrack, Ph.D.

Industrial Noise and Hearing Loss in a Controlled Population: First Report of Findings. Charles D. Yaffe,* Herbert H. Jones, and Edward S. Weiss. Indust. Hyg. J. 19:296-312. (Aug.) 1958. (*U. S. Dept. of Health, Education and Welfare, Public

Health Service, Occupational Health Program, 1014 Broadway, Cincinnati.)

This paper contains the preliminary findings from a study of the hearing of a controlled population selected from four federal prisons. The study has extended over approximately four years, and data on hearing loss due to age have been obtained on persons newly admitted to the prisons. This data pertaining to hearing capability as related to aging contrast sharply with the data obtained during the 1954 Wisconsin State Fair study as showing less hearing loss for age groups 30-39 and above. Another part of the study reported describes the hearing losses of individuals exposed to various industrial noises and various sound pressure levels after the individuals had worked in these noises for one year. After daily exposure to continuous, steady noises, individuals have shown significant elevations of the threshold hearing level (increased hearing loss) or no significant change in threshold hearing level, depending on the noise spectrum and sound pressure level of the noise to which they were exposed. The studies on exposure to intermittent noise are less conclusive but suggest that intermittent noise must be at higher levels to produce the same degree of elevation of the threshold hearing level.

The Relations of Hearing Loss to Noise Exposure. Walter A. Rosenblith et al. American Standards Association, Inc., 70 E. 45th Street, New York, 1950.

The Exploratory Subcommittee Z24-X-2 of the American Standards Association, under the chairmanship of Professor Rosenblith, gathered and analyzed available, relevant data to determine whether it is possible to prepare standards for tolerable noise exposure. The Committee concluded that standards could not be prepared at the time it finished its analyses. Data were summarized on the following topics: presbycusis: effects of continuous exposure to steady noise; effects of intermittent exposure to steady noise; and the effects of impulsive and impact noise. In addition, the committee described unsolved problems, some of which are problems of sampling; the significance of average values and individual variations of hearing losses; and the relation of temporary threshold shifts to persistent or permanent hearing loss. A major contribution by the Committee was the statement of specific questions to be answered before standards are established. Examples of these questions are "What kind and amount of hearing loss constitutes a sufficient handicap to be considered undesirable?" "What role should presbycusis play in setting such a figure?" "What percentage of the persons exposed to industrial noise should a standard be designed to protect?" "How should noises be specified and exposures measured?"

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Medical Principles of Monitoring Audiometry. Hallowell Davis, Gordon Hoople, and H. O. Parrack. A.M.A. Arch. Indust. Health 17:1-20 (Jan.) 1958. (Reprints obtainable from Subcommittee on Noise in Industry, 111 N. Bonnie Brae, Los Angeles 26.)

The authors state the basic principles underlying a special form of audiometric testing, identified as "monitoring audiometry." Monitoring audiometry is essential to effective hearing conservation programs because the criteria for hazardous noise-exposure and the safety regulations based upon them are statistical in nature and, therefore, the status of any individual's hearing must be determined by constant monitoring. Several new terms and concepts are defined, in the hope that the use of the definitions would improve the understanding of problems pertaining to noise-induced hearing loss and also remove the confusion now created by the use of the term "hearing loss" to represent at least three distinct concepts. Persons responsible for establishing and maintaining conservation-of-hearing programs in industrial facilities will find that the basic principles stated are absolutely essential to the formulation of an adequate program and for describing this program to others, particularly management personnel.

Noise and Man, Volume II of Handbook on Acoustic Noise Control. Walter R. Rosenblith and Kenneth N. Stevens. WADC Technical Report 52-204, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, June 1953.

This report summarizes and evaluates selected published literature pertaining to the effects of noise on man, including effects on hearing and on other body functions. In the section on human response criteria for noise control, criteria are given for prevention of hearing loss. This section clearly states the data and the assumptions upon which the "criteria for prevention of hearing loss" are based and, in addition, explicitly states the limitations of the tentative criteria proposed. These criteria have been employed by the Air Force and also by industrial organizations as guides for determining when noise reduction and other hearing conservation procedures are required. The criteria for prevention of hearing loss provide the industrial physician with a starting point in establishing criteria for noise exposure compatible with the maintenance of adequate hearing capability among employees working in the noise within his industrial facility.

NOTE: This document may be obtained from the Office of Technical Services, Department of Commerce, Washington 25, D.C.

About the Authors

ROBERT A. KEHOE, M.D., whose article on "Occupational Medicine — Whither and How!" launches this new journal, has for many years been widely known as an investigator and teacher in the University of Cincinnati College of Medicine, and as a practitioner and consultant in industrial medicine and hygiene. He graduated from this same university with the degree of Bachelor of Science in 1918 and that of Doctor of Medicine in 1920. He continued in the same institution and in an adjacent hospital as a pathologist for a time, but shortly, as a member of the Department of Physiology of his medical college, he engaged in an experimental study of heavy metal poisoning. This was followed soon by his early identification with a systematic study of the metabolism of lead and of lead poisoning on a broad basis, the establishment of The Kettering Laboratory in the medical college, and the assumption of coincidental responsibilities as medical director of Ethyl Corporation. Under Dr. Kehoe's continuing direction, the research activities of The Kettering Laboratory have continued to explore the problem of lead poisoning but have, in addition, moved broadly over the field of industrial chemicals.

Early in their development, the investigative approaches of the Laboratory called for correlations of the results of animal experimentation with clinical data on experimental subjects within the Laboratory and epidemiologic studies in the field. The staff and facilities of The Kettering Laboratory form the base of the University's Institute of Industrial Health, which engages in graduate education in industrial medicine and hygiene. These facilities are also joined with those of the formerly separate Department of Preventive Medicine, to form a single Department of Preventive Medicine and Industrial Health, with responsibility for undergraduate medical instruction. Dr. Kehoe is the Director of this department of the Institute. The Institute accepted its first class of physicians for graduate training in 1947 and its first class of industrial hygiene engineers in 1956.

Dr. Kehoe is prominently identified with the activities of the American Board of Preventive Medicine and with the American Medical Association's Council on Industrial Health. He was recipient of the Knudsen Award of the Industrial Medical Association in 1949 and the Award of the American Academy of Occupational Medicine in 1957.

OSCAR A. SANDER, M.D., of Milwaukee, practices as a consultant in occupational medicine. His college and preclinical medical school education were completed at the University of Wisconsin, and he received the degree Doctor of Medicine from the University of Pennsylvania in 1927. Thereafter, he interned at Mercy Hospital in Pittsburgh and remained for a year of additional training in cardiology. This was followed by a year at Erdheim Institute of Pathology in Vienna, which aroused in Dr. Sander a keen interest in pulmonary tuberculosis that was destined to shape his career.

Upon establishing a practice in Milwaukee he became identified with tuberculosis control work, and this, in turn, led him into studies of silicosis among foundrymen of that city. Although this subject claimed most of his time and energies for several years, there was a continuing extension of his interests into other occupational diseases as well as the general field of industrial medicine.

Dr. Sander is Associate Clinical Professor of Medicine at Marquette University, on the consulting staffs of Columbia and of Milwaukee County Hospitals, a member of the American Medical Association's Council on Industrial Health, Chairman of the Medical Committee of the Industrial Hygiene Foundation, and recently has accepted committee appointments which are devoted to clarifying present concepts of pneumoconiosis. His article in this issue, "Newer Concepts of the Pneumoconioses," is related directly to these latest commitments.

SVEN FORSSMAN, M.D., Stockholm, Sweden, is widely known in the United States. He has visited here extensively, and has published original articles in our journals. For years he directed the interests of his government in the occupational health problems of Sweden. In recent years he has served as medical advisor to the Swedish Employers' Association, while actively serving as Associate Professor of Occupational Health at Karolinska Institutet in Stockholm. During leaves of absence he has worked on special assignments in occupational health for the World Health Organization. It is from this experience that he has prepared his article in this issue, Industrial Health in Industrialized and Nonindustrialized Countries—a Comparative Study. He was on a WHO consultation in Egypt during the last months of 1958, when this paper was written. Although Dr. Forssman's interests are now in the broader relationships of the industrial environment and the general health level of the worker, his research activities began in the field of biochemistry. From this he moved into toxicology and then into studies of occupational diseases. This transition is revealed in the titles of his published papers: "Study on the Metabolism and Effect of Succinic Acid in Vivo" (*Acta physiol. scandinav.*, 1941) and, after a long list of other titles, "The Health Problems of the Older Worker—a Study in Swedish Industry" (*Tr. A. Indust. M. Officers*, 1957). Dr. Forssman is president of the Permanent Com-

mittee and International Association on Occupational Health.

EARL D. MCBRIDE, M.D., is probably best known among industrial physicians for his textbook, "Disability Evaluation," now in its fifth edition. In other circles, he is identified as one of this country's foremost orthopedic surgeons. He received the Doctor of Medicine degree from the College of Physicians and Surgeons, Columbia University, in 1914, and saw active duty in World War I as a captain in the American Medical Corps, assigned to British service from 1917 to early 1919. Thereafter he established the clinic in Oklahoma City which bears his name and began a practice limited to orthopedic surgery. He has continued in this activity to date.

At the present time Dr. McBride is Clinical Professor of Orthopedic Surgery at the University of Oklahoma School of Medicine, chief of staff and chief surgeon at the Bone and Joint Hospital and the McBride Clinic, and consulting and attending orthopedic surgeon at a long list of hospitals in Oklahoma City. He is a certified specialist of the American Board of Orthopedic Surgery and a member of the American Orthopedic Association and the American Academy of Orthopedic Surgeons. He is a past president of the Oklahoma County Medical Society and the originator as well as past president of the Oklahoma City Clinical Society.

Besides his well received textbook, Dr. McBride is the author of about 65 published papers that deal with various aspects of orthopedic surgery with the exception of a few that discuss disability evaluation. His contribution to this journal's first issue is the article, "Management of Trauma in Relation to Permanent Disability."

SEWARD E. MILLER, B.S., M.D., through a combination of appointments at the University of Michigan—School of Medicine (Professor of Medicine), School of Public Health (Professor of Industrial Health and Chairman of the Department of Industrial Health), and Institute of Industrial Health (Director)—heads the total Ann Arbor campus activities in the occupational health field. These include impressive programs of services to industry on campus and in the field on both clinical and environmental problems; the teaching of occupational health to medical students at the undergraduate level, and the teaching of industrial health to graduate students. In addition, his departments undertake basic and applied research on various problems in industrial hygiene and occupational health. The industrial hygiene and toxicology studies largely are conducted at the School of Public Health, while the occupational disease studies and basic research investigations are carried out in cooperation with appropriate departments of the Medical School.

Dr. Miller's article, "The Present Role of Government in Occupational Health," is supported by 20 years' active experience in the United States Public Health Service, including service in hospitals, in the field, and in Washington, D.C. Twelve of these years were spent in pathology and in communicable disease work, from which background Dr. Miller produced his "Textbook of Clinical Pathology," currently the most widely used in its field. He was Chief, Division of Occupational Health, USPHS from 1951 until returning to the faculty of his alma mater in his present capacities in 1956.

Dr. R. S. F. SCHILLING is Director of the Rockefeller Unit of Occupational Health in the London School of Hygiene and Tropical Medicine. His article in this issue is entitled "Epidemiology of Byssinosis—Adventure and Misadventure" and is his 29th published paper in the field of occupational health. Dr. Schilling attended Epsom College, after which he took his medical work at St. Thomas's Hospital in London. He received the M.B., B.S. degree from London University in 1937, and from the same institution received the M.D. degree, the D.P.H. (with distinction), and the D.I.H. He was Assistant Medical Officer, I.C.I. (Metals) Ltd., Birmingham, in 1937-1938, and Secretary, Industrial Health Research Board of the Medical Research Council, 1942-1946. He was appointed Nuffield Medical Fellow in Industrial Health in 1946, and became lecturer and then reader in the Nuffield Department of Occupational Health in the University of Manchester beginning 1947. In the same year he was appointed editor of the *British Journal of Industrial Medicine.* He saw war service in the Royal Army Medical Corps and in the Factory Inspectorate. Dr. Schilling presented the Milroy Lecture of the Royal College of Physicians, London, in 1956, and was Mackenzie Lecturer, British Medical Association, in the same year. During the years 1955-1957, he was president of the Association of Industrial Medical Officers of Great Britain and Northern Ireland.

RUTHERFORD T. JOHNSTONE, M.D., is a private practitioner of occupational medicine in Los Angeles, whose professional interest has for over 20 years been settled upon an area he chooses to call clinical toxicology. His article in this issue describes that activity. After graduating from the University of Pittsburgh in 1925 he practiced internal medicine in Pittsburgh and taught at his medical school for 10 years, at which time he moved to California to take charge of the department of medicine in the Golden State Hospital, Los Angeles. This was a hospital which served numerous small industries of that city, and Dr. Johnstone's responsibilities in this organization led to an enduring interest in occupational disease diagnosis. Shortly after joining its staff Dr. Johnstone established the Department of Occupational Diseases, probably the first in any hospital in this country. He continued in this activity until he estab-

lished his present practice, in 1945. His patients come from other physicians, numerous insurance companies, and employers, and their problems usually have to do with determinations of cause and degree of disability. These determinations frequently depend upon nonclinical data. The pursuit of answers to patient-centered questions has lead to field studies of the work environment and a consequent wide interest in the general field of industrial hygiene.

Dr. Johnstone's first book, "Occupational Diseases," which appeared in 1942, was planned to help the general practitioner develop diagnostic competence in this special field. The book enjoyed a favorable reception, as did two others subsequently written: "Industrial Toxicology," of which he was a coauthor with Alice Hamilton, and Occupational Medicine and Industrial Toxicology," a standard text for industrial practitioners and students which is currently undergoing revision.

RAYMOND R. SUSKIND, M.D., a native of New York City, has spent the last 10 years at the University of Cincinnati, where he is presently Associate Professor of Dermatology as well as Associate Professor of Industrial Medicine. He has helped to develop, at the University of Cincinnati, a rather unique coordinated research and postgraduate teaching program, involving the Department of Dermatology, The Kettering Laboratory, and the Institute of Industrial Health. The areas covered by courses in this program include physiology and chemistry of the skin, cutaneous allergy, occupational dermatoses, and clinical instruction from hospital patients and outpatients. His researches have included problems relating to (1) the influence of environmental factors on cutaneous sensitization and irritation; (2) the pathogenesis of acne vulgaris and occupational acne; (3) the effect of soaps and synthetic detergents on the skin; and (4) development and appraisal of cutaneous protectants. These have formed the basis of some 13 significant articles and reports, of which two are currently in press. Dr. Suskind is a specialist certified by the American Board of Dermatology. He is a member of local and national societies and academies of dermatology and has held responsible offices in them. He is a member of the American Association for the Advancement of Science and of Sigma Xi. Dr. Suskind's topical review, entitled "Mechanisms of Dermatologic Response," is the first of a series based in part upon the course of postgraduate instruction presented at the University of Cincinnati.

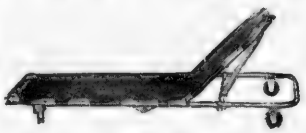
GEORGE ROUSH JR., M.D., is Medical Director of Callery (Pennsylvania) Chemical Company, whose products include the family of compounds called, collectively, boranes. Dr. Roush graduated in engineering from the University of Wisconsin. After the war he entered the medical school of Washington University (St. Louis) and graduated in 1951. He interned at Marquette University, in Milwaukee County Hospital. This was followed by five years of training in occupational medicine and in internal medicine at the University of Pittsburgh, the National Institutes of Health, and Staten Island Marine Hospital.

During this time he was awarded fellowships by the U.S. Atomic Energy Commission, the U.S. Public Health Service, and the University of Pittsburgh. Dr. Roush serves as clinical instructor in medicine and in occupational medicine at the University of Pittsburgh. He is the author of the topical review "Toxicology of the Boranes," in this issue.

Occupational Health Commendation

Robert H. Duguid, M.D., Scientific Director of the United States Army Environmental Health Laboratory, was recently presented a commendation award and a $300 check in recognition of his contributions in Occupational Health which were cited as being of immeasurable assistance in furthering the prestige of the Laboratory and in "gaining for it recognition as a leader in the occupational health program of the United States Army." The award was presented by Lt. Col. Edward J. Dehne, Commanding Officer of the Laboratory.

PARTNERS



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People and Events

► GEORGE F. WILKINS, M.D., has been appointed Associate Clinical Professor of Occupational Medicine at Harvard University. DR. WILKINS is medical director of New England Telephone and Telegraph Company in Boston. He has been with the Company's medical department since 1935.

DR. WILKINS obtained his A.B. degree from The College of the Holy Cross, Worcester, in 1928, and his M.D. degree from Harvard University in 1932. He was president of the INDUSTRIAL MEDICAL ASSOCIATION, 1953-1954.

► In honor of ROBERT T. LEGGE, M.D., Berkeley, California, the Western Industrial Medical Association recently presented a $500 check to the East Bay Rehabilitation Center of the Herrick Hospital, Berkeley. DR. LEGGE, who was one of the founders and the first president of the Western Industrial Medical Association, has just completed a history of the organization which was two years in preparation. It is contained in four bound volumes which are available on loan from the Western IMA. Another honor recently to come to DR. LEGGE was to have an L.L.D. degree conferred on him by the University of California. DR. LEGGE was recipient of the Knudsen Award in 1951.

► WILLIAM P. YANT, SC.D., has been elected Chairman of the Board of Trustees of the Industrial Hygiene Foundation, and H. H. SCHRENK, PH.D., has been named Managing Director, to succeed C. RICHARD WALMER, M.D., who is returning to private medical practice. DR. YANT is Director of Research and Development for Mine Safety Appliances Company, and DR. SCHRENK has been Research Director of the Foundation since

Free Choice? Closed Panel?

THE long-awaited report of the Commission on Medical Care Plans, American Medical Association, will be distributed as a special supplement to the January 17, 1959, issue of the AMA Journal. This comprehensive study and report contains sections having considerable interest for industrial physicians — Free Choice of Physician; Third Party Relationships; Scope of Current Industry Programs; and Medical Relations in Workmens Compensation.

At the December Clinical Meeting of the American Medical Association in Minneapolis, the report (distributed only to delegates prior to the meeting) was discussed for two hours at a reference committee hearing, but the House of Delegates decided to defer action until the June, 1959, meeting. In so doing, the delegates adopted this statement:

> We respectfully suggest to the constituent associations reviewing the report in the interim, that their attitude regarding the report will be clarified if they arrive at some decisions in regard to the following basic points:
>
> 1. *Free Choice of Physician*—Acknowledging the importance of free choice of physician, is this concept to be considered a fundamental principle, incontrovertible, unalterable, and essential to good medical care without qualification?
>
> 2. *Closed Panel Systems*—What is or will be your attitude regarding physician participation in those systems of medical care which restrict free choice of physician?
>
> These suggestions acknowledge that the policy of the American Medical Association to encourage and support the highest quality of medical care for all patients remains unchanged. They question, however, whether attitudes toward the free choice of physician and the closed panel system may be undergoing evolutionary change.

The House recommended that the Board of Trustees invite the constituent associations to forward their replies to these questions to the Executive Vice President 60 days in advance of the June, 1959, meeting.

William P. Yant, Sc.D.

H. H. Schrenk, Ph.D.

1949. Both DR. YANT and DR. SCHRENK are widely experienced in the fields of industrial and public health. DR. SCHRENK directed the Donora smog investigation for the U.S. Public Health Service, and is a recipient of the Donald E. Cummings Memorial Award from the American Industrial Hygiene Association for outstanding contributions to his profession.

DR. YANT recently received the Arthur Williams medal of the American Museum of Safety for "outstanding contribution to the conservation of human life." During his long career, devoted to the improvement of health and safety, DR. YANT has invented devices covered by 66 domestic and foreign patents. He participated in the formation of the Industrial Hygiene Foundation and has served as a trustee since its inception.

► The 11th annual meeting of the American Academy of Occupational Medicine will be held in Boston, February 11-13, 1959, with headquarters at the Sheraton Plaza Hotel. The program follows:

February 11: Symposium, "Pharmacological and Biochemical Approaches to Mental Disorders"—MARK ALTSCHULE, M.D., McLean Hospital, presiding; field trip to review research projects at Massachusetts Institute of Technology.

February 12: Symposium, "Transplantation of Tissues and Organs" — FRANCIS D. MOORE, M.D., JOHN MERRILL, M.D., and other physicians of the Peter Bent Brigham Hospital; "Recent Advances in Therapy of Infectious Diseases" — LOUIS WEINSTEIN, M.D., Boston University School of Medicine; "Fatalities from EDTA in Lead Intoxication" — HEINRICH BRUGSH, M.D., Division of Occupational Hygiene, Commonwealth of Massachusetts; "Recent Work on Atmospheric Pollution and Synergistic Action of Certain Substances Involved" — MARY O. AMDUR, PH.D., Harvard School of Public Health; "Physiological Aspects of Human Fatigue" —DR. WILLEM S. FREDERIK, Liberty Mutual Insurance Company.

February 13: "Ocular Effects of Radiation (Ionizing and Electromagnetic)" — DAVID G. COGAN, M.D., Harvard Medical School; Symposium in four parts: "Fundamentals of a Nuclear Reactor"—PROFESSOR THOMPSON, Massachusetts Institute of Technology Nuclear Reactor; "Health Hazards Associated with Nuclear Reactor" —PROFESSOR MALETZKOS, Massachusetts Institute of Technology Nuclear Reactor; "Clinical Applications of Reactor Products—Isotopes"—MARTIN LUBIN, M.D., Harvard Medical School; "Clinical Applications of Reactor Products—Energy"—speaker to be announced.

► HOWARD H. SMEAD, M.D., was recently appointed plant physician for the Ford Motor Company's Assembly Plant in Lorain, Ohio. DR. SMEAD received his M.D. degree in 1937 from the State University of Iowa, College of Medicine. He was a flight surgeon with the U.S. Air Force from 1941 to 1946. In 1947, he became medical director of Solar Aircraft Company in Des Moines, and has remained in that position until his present appointment. He is a Fellow of the Industrial Medical Association.

► H. B. ALLEN, M.D., has been appointed medical director for Abraham and Straus in New York City. For the last four years, he has been medical director of the Maytag Company in Newton, Iowa.

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The Consultant Editor, Howard N. Schulz, is well known in the field of Industrial Hygiene. Among other activities in the American Industrial Hygiene Association, he served as Editor of the *AIHA Quarterly* from 1955, until April, 1958.

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DR. ALLEN received his M.D. degree from the University of Minnesota in 1936 and was on the staff of the United Hospital in Rochester, New York, from 1938 to 1941. He served two stretches with the U.S. Army, from 1941 to 1946 and from 1949 to 1952. Between his two terms with the Army, he was medical examiner for the Pennsylvania Railroad.

► The Canadian Medical Association is reconstituting its Committee on Occupational Medicine, under the chairmanship of DR. R. G. WARMINTON of Cyanamid of Canada Ltd., Niagara Falls, Ontario.

► KENNETH E. MARKUSON, M.D., has been appointed medical director, Loss Prevention Department, Liberty Mutual Insurance Company in Boston. For the last six years, he has been Division medical director for Liberty Mutual's Philadelphia office.

DR. MARKUSON received his M.D. degree from Creighton University School of Medicine in 1931, and a masters degree in Public Health from The Johns Hopkins University in 1936. Prior to joining Liberty Mutual, he served as Director, Division of Industrial Health, Michigan Department of Health,

Kenneth E. Markuson, M.D.

and before that, as Director, Bureau of Industrial Hygiene, Connecticut State Health Department.

During his career, DR. MARKUSON has been affiliated with several universities. He was assistant professor of industrial medicine at Wayne State University College of Medicine in Detroit, and non-resident lecturer at the University of Michigan Medical School and the Yale University Department of Public Health. He is currently associated with Tufts University School of Medicine and the Harvard School of Public Health as part-time lecturer. DR. MARKUSON is a past president of the Michigan Industrial Medical Association and a past president of the American Conference of Governmental Industrial Hygienists.

► JOSEPH H. CHIVERS, M.D., retired medical director of the Crane Company, and recently of the Medical Advisory Committee of the Rehabilitation Institute in Chicago, has just returned from a three-month European trip, and is presently living in the Los Angeles area.

► CHRISTOPHER LEGGO, M.D., has accepted the position of medical officer for the California State Personnel Board, and is now located in Sacramento. DR. LEGGO was a founder and first secretary of the Western Industrial Medical Association.

► ROBERT E. ECKARDT, M.D., Director, Medical Research Division, Esso Research and Engineering Company, received a citation for distinguished service from the Medical Advisory Committee of the American Petroleum Institute at the Institute's annual meeting in

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Chicago in November. DR. ECKARDT is First Vice President of Industrial Medical Association.

► During Canada's 15th National Health Week, February 1-7, 1959, special attention will be given to industrial health. National Health Week is sponsored by the Health League of Canada, a national citizens' committee of the World Health Organization in cooperation with Departments of Health and Education.

► H. GLENN GARDINER, M.D., received the Northwest Indiana Heart Foundation's highest award, a silver distinguished achievement medallion, for outstanding service in the area fight against heart disease. DR. GARDINER is a past president of the local heart organization and recently was chosen president-elect of the Indiana Heart Foundation. He is medical director of Inland Steel Company, East Chicago, Indiana, and a member of the Board of Directors of the INDUSTRIAL MEDICAL ASSOCIATION.

► Fifteen representatives from seven countries will meet in Johannesburg, South Africa, February 9-21 to discuss the etiology, pathology, diagnosis and prevention of pneumoconiosis. Delegates representing the United States, United Kingdom, Belgium, Germany, France, Switzerland and Northern Rhodesia will convene at the invitation of the Pneumoconiosis Research Unit of the South African Council for Scientific and Industrial Research. The conference theme will be twofold: (a) a critical review of what is known and of recent contributions to knowledge of the disease; and (b) the program for future research, particularly in prevention.

The three delegates from the United States will be THEODORE F. HATCH, Professor of Industrial Health Engineering, Department of Occupational Health, Graduate School of Public Health, University of Pittsburgh; O. A. SANDER, M.D., Associate Clinical Professor of Occupational and Environmental Medicine, Marquette University School of Medicine, Milwaukee; and A. J. VORWALD, M.D., Wayne State University College of Medicine, Detroit. DR. VORWALD has been elected Vice President of the conference, and will serve as chairman of the session on February 12.

All three American delegates will present papers. MR. HATCH will discuss "Respiratory Dust Retention and Elimination." DR. SANDER will give two papers, "Radiological Appearances of the More Common Pneumoconioses and of Other Conditions Which Stimulate Them" and "The Effect of Continuing in Original Dusty Occupation on the Progression of Pneumoconiosis." DR. VORWALD will also present two papers, "The Bioassay of Dust with Particular Reference to Experimental Methods" and "The Significance of Submicroscopic Particles in the Pathogenesis of Pathology of Silicosis."

Delegates from other countries include six from the United Kingdom: PROF. E. J. KING, Postgraduate Medical School of London; PROF. JETHRO GOUGH, Institute of Pathology, Royal Infirmary, Cardiff; DR. J. C. GILSON, O.B.E., Director, Pneumoconiosis Research Unit, Llandough Hospital, North Penarth; DR. JOHN ROGAN, London; DR. G. NAGELSCHMIDT, Sheffield Safety in Mines Research Establishment; and DR. A. MEIKLEJOHN, University of Glasgow. From Belgium's Insitute de Hygiene des Mines will come DRS. A. HOUBRECHTS and F. LAVENNE. Germany will send DR. GUNTHER WORTH of Krankenhaus Bethanien, Moers am Rhein. France will be represented by PROF. POLICARD of Lyons' Institute d'Histologie, Faculte d'Medecine. DR. P. H. ROSSIER of Zurich will represent Switzerland; and DR. ROBERT PAUL, Director of the Silicosis Bureau in Kitwe, will be Northern Rhodesia's delegate.

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